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ABSTRACT

Designed for adult basic education students at the grade 7, 8, or 9 level, this student workbook and accompanying instructor's guide (separate document) comprise the Adult Basic Education Level III package on the metric system. The content of this workbook is occupationally oriented. (There are references to measurement tasks used within 50 different occupations.) Each of the five activity sections (linear, area, volume and capacity, and temperature) uses a problem solving approach to the metric system and presents hands-on activities which introduce appropriate concepts, measurement words, and measurement devices. Supplementary diagrams and charts are included. (SH)

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THE CENTER FOR VOCATIONAL EDUCATION

The Ohio State University • 1960 Kenny Road • Columbus, Ohio 43210

# Metrics for Good Measure

LEVEL III STUDENT WORKBOOK

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U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
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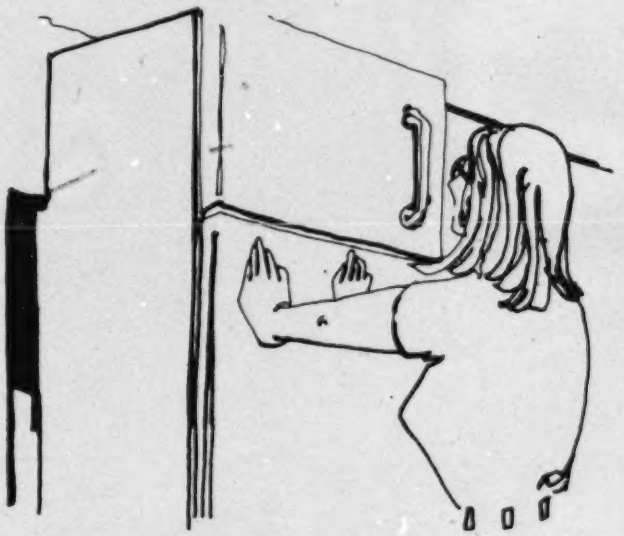
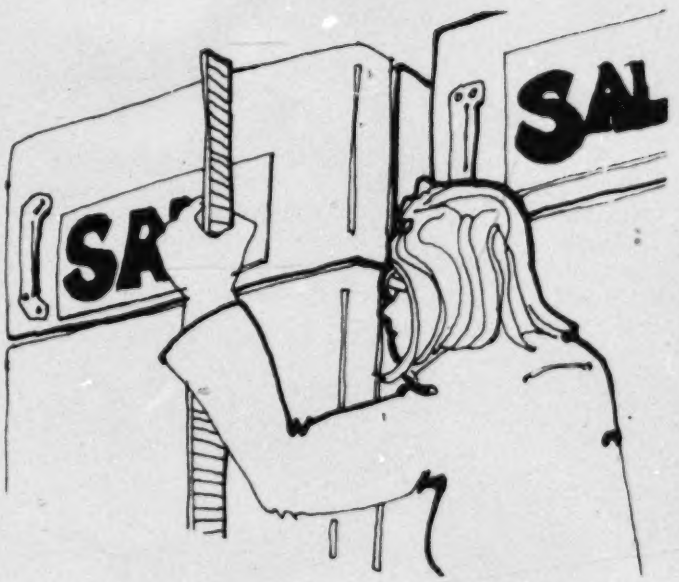
# METRIC MEASUREMENT

People usually measure something almost every day. When you make coffee you need to measure the amounts of water and coffee to use. When you cook you measure the amount of each item used in the recipe. When you drive you measure the speed of the car. Whenever you build something with wood you stop to measure before you saw a board. If you don't take the time to measure, you may have problems.



For example, look at the woman in the picture. Her new refrigerator has just been delivered. Her problem is that the refrigerator will not fit in the space where she wants it. The refrigerator is too high! What could she have done before she bought the refrigerator to avoid this problem?

She could have done two things. She could have measured the space where she was going to put the refrigerator. She also could have measured the refrigerator at the store, to see if it would fit in the space. She was able to exchange her new refrigerator for one that fits.



In the second picture we see the woman measuring the height of another refrigerator. She is measuring so that she will not make that same mistake again.

This person planned ahead. He has a place where he wants to put a television set. Before he went shopping he measured the space where he wants to put the TV. In this picture he is measuring the height. To be sure the set will fit he should also measure the width and the depth of the space. He has measured the space and he is measuring the TV set, so he knows if that set will fit in the space where he wants to put it.

Here are some more people who have not planned ahead. They are trying to get a sofa through the doorway. The sofa will not fit because it is too wide. What could the people have done before they tried to move the sofa through the doorway? They could have saved a lot of hard work if they had planned ahead by measuring first.

These are just some of the times when people need to measure. They need to measure things at home, at work, and at play. The United States is changing to the metric system. More and more companies are using the metric system and in a few years everyone will need to know it. If you take the time to learn it now, you will have a better chance of getting a job.

The metric system is easy to learn and easy to use. On the next page you will begin using the metric system, and the more that you use it the better you will know it. Pretty soon you will even begin to THINK METRIC!

## METRES

The metre is the foundation of the metric system. Whenever you measure the length, width, height or depth of something you will measure it in metres or parts of metres. There are several tools used for measuring metres: a metric tape, a folding rule, a steel tape, a trundle wheel, and a metre stick. Some of these tools come in different lengths. But, the metre stick comes in just one length--a length of one metre. The first set of activities will give you a chance to use a metre stick.

On the resource table you should find some metre sticks. You will use them for the first six activities. Some metre sticks are blank. They are just a piece of wood, plastic, or metal that is one metre long. Some metre sticks have lots of marks on them. If you get a metre stick with lots of marks--ignore the marks for now. For the following activities you will only need to measure things in metres.

## Metric Activities

### Activity 1. A METRE HIGH

Go to the resource table. Pick up one of the metre sticks and stand the stick up on the floor. Hold it in place with one hand. Walk around the stick. Now stand next to the stick. With your other hand, touch yourself at the top of the metre stick. This is how high a metre is. Put the stick down. Do it again until you can touch yourself where you are a metre high.

### Activity 2. A METRE LONG

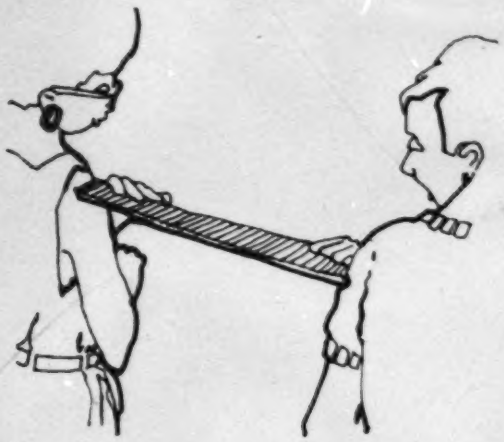
Pick up the metre stick again. Hold one arm out straight at shoulder height. Put the metre stick along this arm until the end hits the tip of your fingers. Where is the other end of the metre stick? Touch yourself at that end. This is how long a metre is. Try to remember the length of a metre.

1.

2.

## Activity 3. A METRE WIDE

Choose a partner. Stand beside each other. Move apart so that you can put one end of a metre stick on your partner's shoulder and the other end on your own shoulder. Look at the space between you. This is the width of a metre. Move away from you partner. Walk around the room. Now move towards each other until you are just a metre apart. Check with a metre stick. Find a new partner and see if you two can stand a metre apart.



## Activity 4. METRE ROOM

Find a partner. Each of you get a metre stick. Measure the length of the room in metres to the nearest metre. Write the length on a piece of paper. Write the letter m for the word metre. If the room is five metres long, write 5 m. Now measure the width of the room in metres. Can you find the height of the room? Save these measures so you can use them in later activities.

## Activity 5. STEPPING METRES

Go out in the hall. Mark a spot on the floor with a piece of chalk. Measure 10 metres down the hall and mark that spot. You now have two marks on the floor and they should be 10 metres apart. Now walk from one mark to the other. How many steps did you take? Keep trying until you take the same number of steps each time.

## Activity 6. METRES AROUND THE ROOM

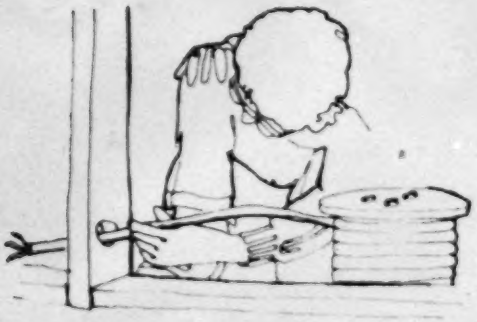
Take your metre stick and measure some big things in the room. Before you measure guess if each object is shorter or longer than a metre. You might measure the height of the doorknob from the floor.

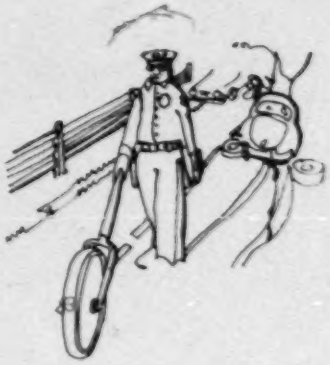
How high are you?
How long is a table?
How high is the window?
How high is the door?
How wide is the window?
How wide is the table?

Guess and then measure. How close were your guesses to the actual measures?

## Metrics at Work

In what kinds of jobs do people use metres? One person who uses metres is an electrician. Lengths of wire come in metres. Before an electrician begins a job, it is necessary to find out how many metres of wire will be needed. Once the electrician knows how much wire is needed, he will know how many rolls of wire to order for that job. By planning ahead and measuring, the electrician is sure that there will be enough materials to finish the job.



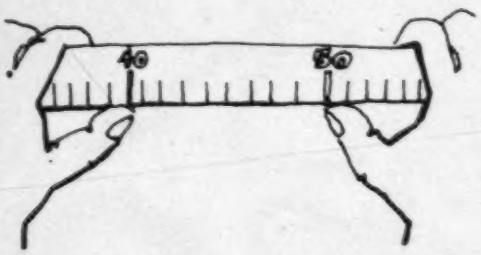


Another person who uses metres is a police officer. In the picture a police officer is investigating an accident. One thing that needs to be included in the accident report is the length of the skid marks made by the car. Here the police officer is using a trundle wheel to measure the length of the skid marks in metres.

A third person who uses metres is a roofer. Rolls of roofing material, like tar paper, come in 40 metre lengths. The roofer needs to know how many rolls of material will be needed so that there is enough to finish the job and not too much left over.

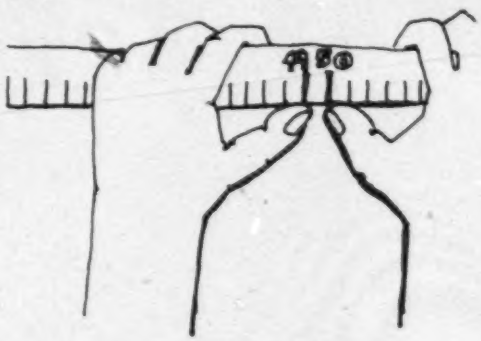
## CENTIMETRES

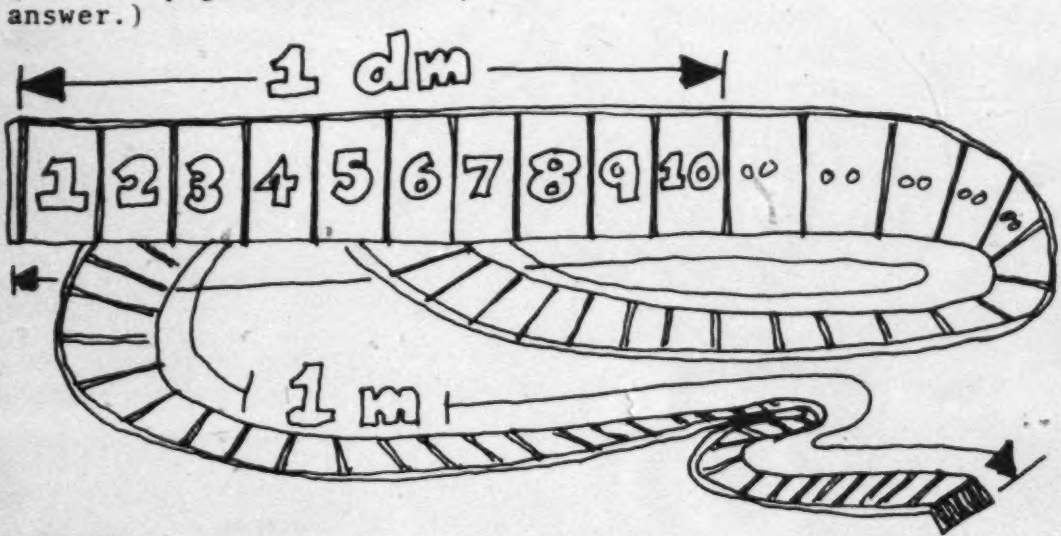
Sometimes a metre is too big for what we want to measure. For example, a cake pan is too small to measure in metres. When that is true we use a part of a metre. If we divide a metre into ten equal parts we have a decimetre. Take a marked metre stick and put one thumb on the number 40 and the other thumb on the number 50. Your thumbs are a decimetre apart.




This picture shows a decimetre. At the left end of the wavy metre is a section that is one decimetre long. How many decimetres are there in one metre? (Turn to page 59 to check your answer.)

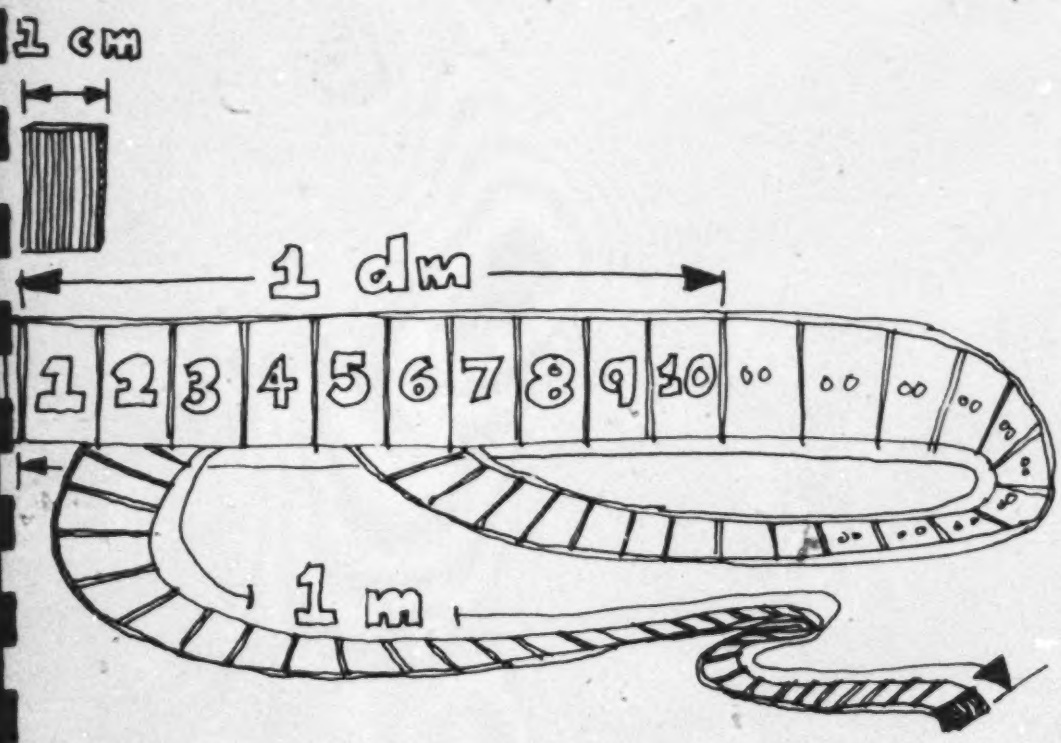
A unit smaller than the decimetre often is used. For example, the diameter of wire is too small to measure in decimetres. This smaller unit is formed by dividing a decimetre into ten smaller parts. Each of these smaller parts is called a centimetre. Take your metre stick and put one thumb at the number 49 and put the other thumb at the number 50. Your two thumbs are now one centimetre apart.

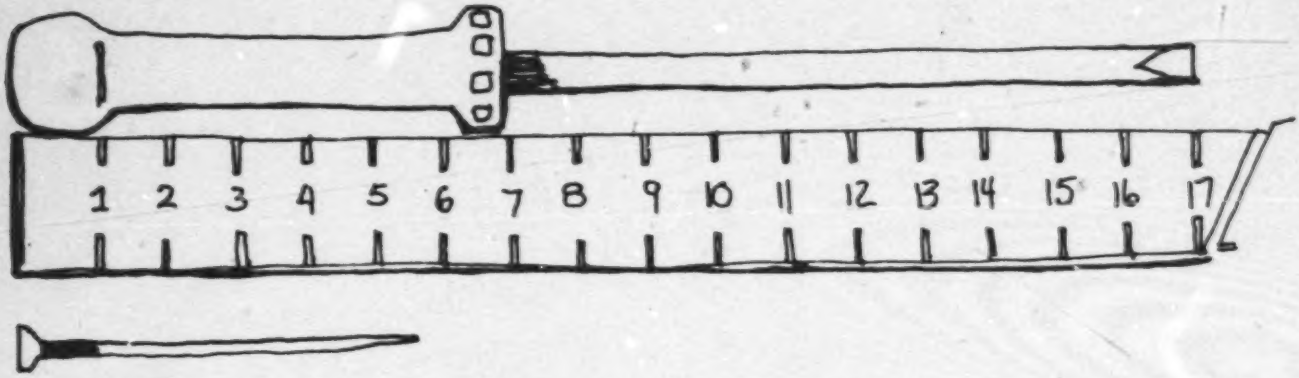


You can get another idea of the size of a centimetre in the picture here. This picture shows a metre, a decimetre, and a centimetre. The symbol cm is used for centimetre. So, if something is 7 centimetres long, you could write this as 7 cm. Make sure you put a space between the numeral (7) and the symbol (cm). No period is placed after any of the metric symbols unless they are at the end of sentences. It is correct to write 7 cm but 7 cm. would not be correct.

Look again at the picture of the metre, decimetre, and centimetre. How many centimetres are there in one decimetre? How many centimetres are there in one metre? Turn to page 59 to check your answers.






Before you begin the Metric Activities section you are going to have a brief lesson on reading a metric ruler. Look at the picture of the screwdriver next to the metric ruler. One end of the screwdriver is at the end of the ruler near the numeral 1. The other end of the screwdriver is at the 17 mark. This means that the screwdriver is 17 cm long.

Now look at the picture of the nail next to the metric ruler. One end of the nail is at the end of the ruler near the numeral 1. The other end of the nail is between the 5 mark and the 6 mark. This means that the nail is between 5 cm and 6 cm long. Is the end of the nail closer to the 5 mark or the 6 mark? It is closer to the 6 mark, so we say that the nail is about 6 cm long. If the end of the nail had been closer to the 5 mark, we would have said that the nail was about 5 cm long.

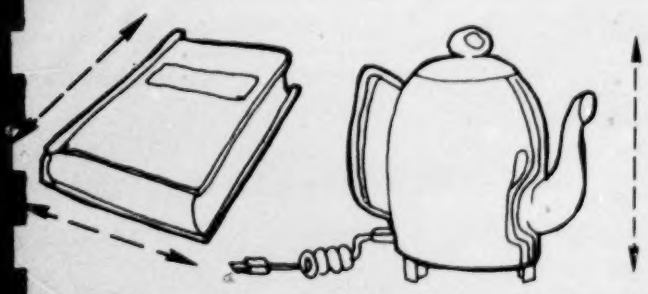
## Metric Activities

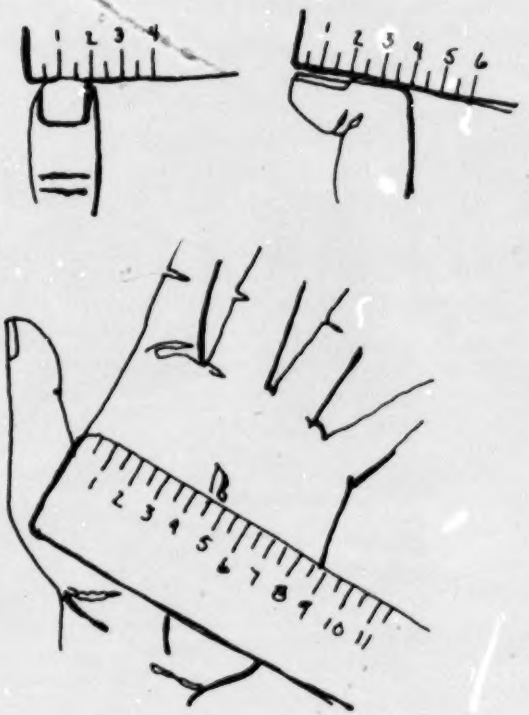
### Activity 7. CENTIMETRES

Go to the resource table and pick up a metric ruler. Put the ruler against your index fingernail. How wide is your index fingernail? Write your answer on a sheet of paper. Bend your thumb at the first joint. Measure this with the ruler. How long is it? Measure the width of the palm of your hand, then the length of your hand. Compare your answers with your neighbor's. Are your answers different? Did you both use the correct symbols?

### Activity 8. GUESS AND MEASURE

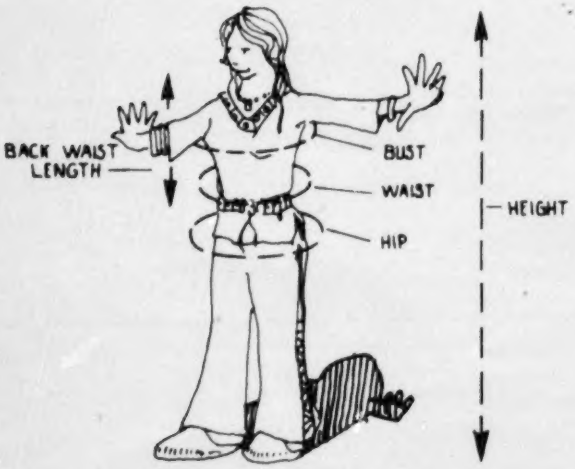
Use your metric ruler to measure the objects on the resource table. You should find a pencil, an eraser, a coffee pot, and a book. Guess the length, width, height, or depth of each object. Write your guesses on a sheet of paper. (Remember to use cm for centimetre.) Now measure each object. How close are your guesses to the actual measurement? You might want to check your measurement with someone else or with the teacher.

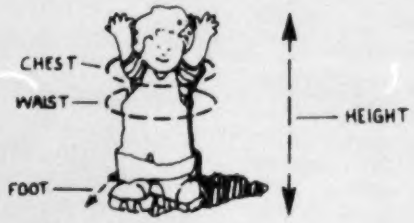




### Activity 9. METRIC TAPE MEASURE

Use a metric tape measure to measure yourself. Most metric tape measures are one and a half metres (150 cm) long. Measure your waist, your hips, your chest, and your neck. Compare these measurements with the Butterick Pattern Measurement Chart. What size pattern would you buy? (Check with your teacher to see if you have the right pattern size.) Also measure the distance around your thumb, the length of your shoe, the length of your forearm, and the length of your leg from the knee to the floor.




## Activity 10. BODY MEASUREMENTS

Fill in the measurements for a man, a woman, and a child or large doll. Be sure to put the symbol cm after each measurement to show that this answer is in centimetres.

A Man

Height _____

Waist _____

Neck _____

Hip (Seat) _____

Sleeve _____

A Woman

Height _____

Bust _____

Hip _____

Waist _____

Back Waist Length _____

A Small Child

Height _____

Chest _____

Waist _____

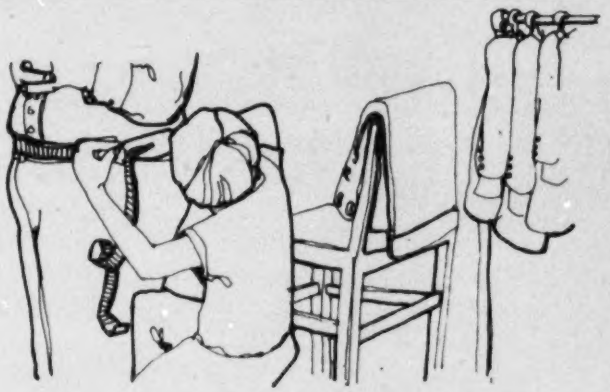
Foot _____

## Metrics at Work

Centimetres are used primarily to measure clothing sizes and parts of the body. People who make or sell clothing, shoes, and fabrics measure with centimetres.

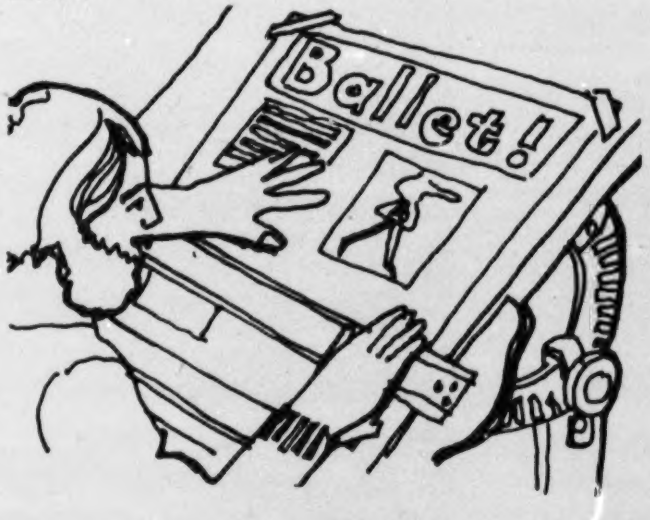
Here is a picture of a shoe clerk measuring a child's foot in centimetres. The shoe clerk can easily find the right shoe size if the clerk knows the length of the foot in centimetres.

In the next picture a man is trying on a suit. The sleeves of the suit are too long. The tailor is measuring the sleeves with a metric ruler in order to find out how many centimetres to shorten the sleeves.



Tailors and sales clerks in clothing stores use metric tape measures. In the third picture a tailor is using a metric tape measure to find a customer's waist measurement.

Nurses and doctors use centimetres to find a person's height. When copywriters, artists, or printers prepare a page layout they must know the number of centimetres each article or ad will use. The cost of an ad is determined by the number of centimetres that it uses.



## MILLIMETRES

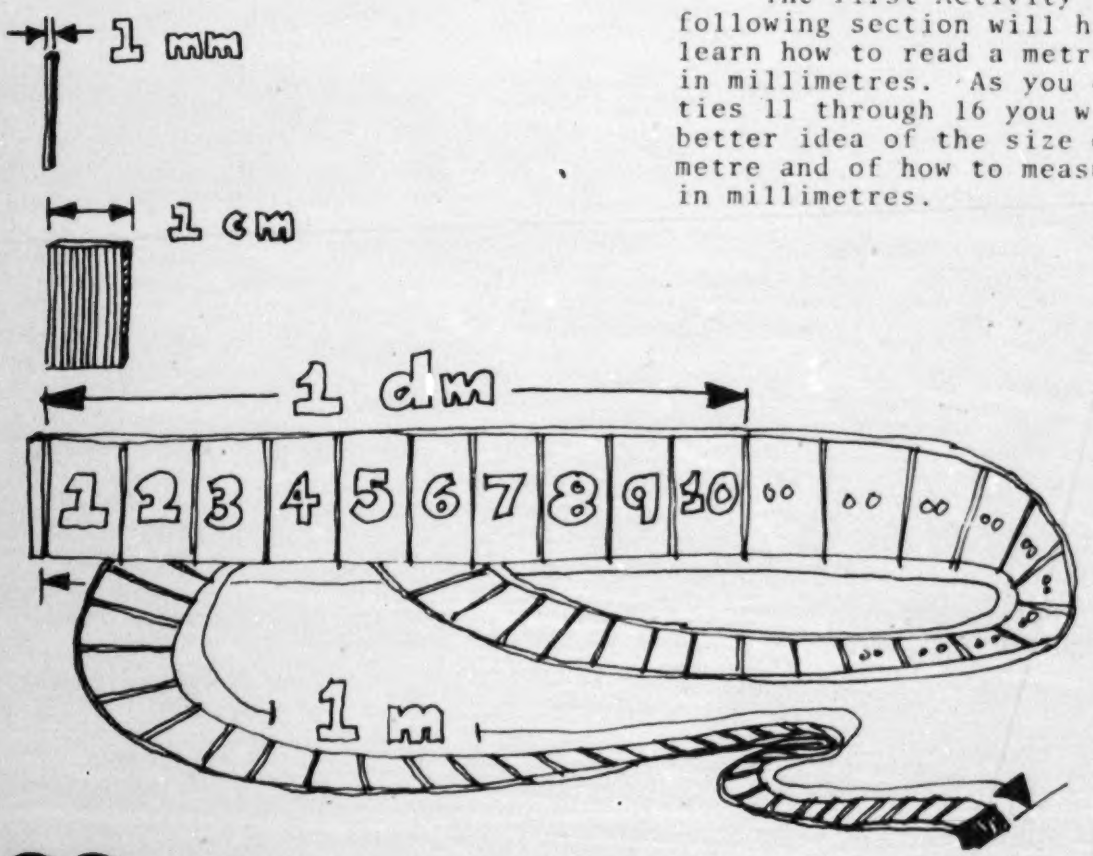
There is one other small unit that a lot of people use for measuring lengths. This unit is called a millimetre. The symbol mm is used for millimetre. You can write 5 mm to show that something is five millimetres long.

A millimetre is made by dividing a centimetre into 10 equal parts. This means that there are 10 millimetres in one centimetre. Since there are 100 centimetres in one metre, how many millimetres are there in one metre? There are 1 000 millimetres in one metre.

Numbers that are one thousand and larger use a space instead of a comma to separate groups of three digits. This is done because many countries use a comma for a decimal marker. In a four-digit number, the space does not have to be used. It is correct to write 6875 or 6 875. In this book we will use the space.

The picture shows a millimetre next to a centimetre, a decimetre, and a metre. This will help you see the size of each of these units and how they compare to each other.

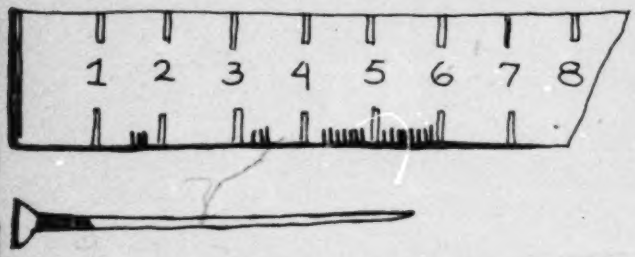
The first Activity in the following section will help you learn how to read a metric ruler in millimetres. As you do Activities 11 through 16 you will get a better idea of the size of a millimetre and of how to measure things in millimetres.



## Metric Activities

### Activity 11. MEASURING MILLIMETRES

Go to the resource table and get a metric ruler. Each of the marks on the ruler is for one millimetre. The centimetres have been numbered. Remember that each centimetre is ten millimetres. So, if you measure something that is 3 cm, this is the same as 3 × 10, or 30 mm.




Look at the picture of the nail next to the ruler. One end of the nail is at the end of the ruler near the numeral 1. The other end of the nail is between the 5 mark and the 6 mark. This means that the nail is between 50 mm and 60 mm long. Now count the number of marks from the 5 to the end of the nail. Did you count 7? This means that the nail is 50 + 7, or 57 mm long.

### Activity 12. MILLIMETRES

Measure the thickness of each of the following: a paper clip, a dime, and a fingernail. How thick are they? They should all be about 1 mm thick.

### Activity 13. ME IN MILLIMETRES

Measure some parts of yourself in millimetres. Write down the measures that you get on a sheet of paper. (Be sure to use the symbol mm.) Some of the parts that you might measure are:

The length and width of your longest finger.
The width of your fingernails.
The width of one of your feet.
The length and width of your little finger.
The width of your palm.

### Activity 14. MORE MILLIMETRES

On the resource table are some things for you to measure in millimetres. Before you measure these objects guess at their measures in millimetres. Write your guesses on a sheet of paper. You should measure the length, width, and thickness of a paper clip. You should measure the diameter and thickness of a button. Make sure that you take enough measures so that you can describe the size of this object to someone else. Some of the objects that you can measure are a paper clip, button, needle, bolt, stapler, pencil, book, and the table. How close are your guesses to the actual sizes?

### Activity 15. UP IN SMOKE

Measure the lengths of the cigarettes on the resource table. Is the 100 mm cigarette really 100 mm? What about the 120 mm cigarette? How long are the other cigarettes? What is the diameter of each cigarette?

## Activity 16. MILLIMETRES & CENTIMETRES

Pick up a 100 mm cigarette. How many centimetres long is it? So, 100 mm = ____cm.

Measure a 120 mm cigarette in centimetres.

120 mm = ____cm.

Measure the toothbrush on the resource table.

____mm or ____cm.

Look at the picture of the nail in Activity 11. The nail is 57 mm long. This is 5 cm and 7 mm. Since there are 10 mm in each cm, then 1 mm = 0.1 cm (one tenth of a centimetre). This means that 7 mm = 0.7 cm and so

57 mm = 5 cm + 7 mm

= 5 cm + 0.7 mm

= 5.7 cm.

Now measure the length of the paper clip. It is 34 mm. This is the same as 3 cm and ____mm. Since each millimetre is 0.1 cm, then 4 mm = ____cm. So, the paper clip is

34 mm = 3 cm + 4 mm

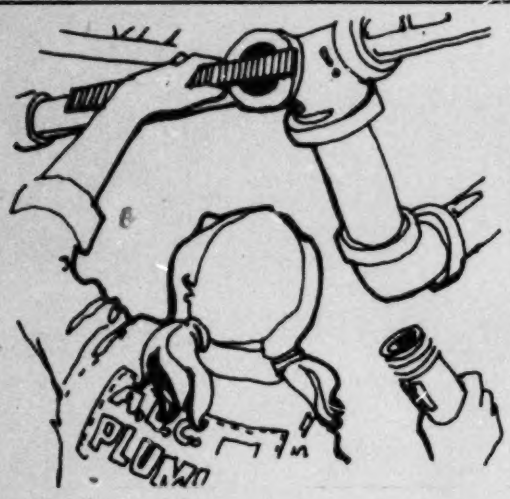
= 3 cm + 0.4 cm

= 3.4 cm.

Measure the toothpick. It is ____mm = ____cm.

Complete the following table to get a better idea of how to change millimetres to centimetres or to change centimetres to millimetres. After you have completed the table check your answers with the answers on page 59.

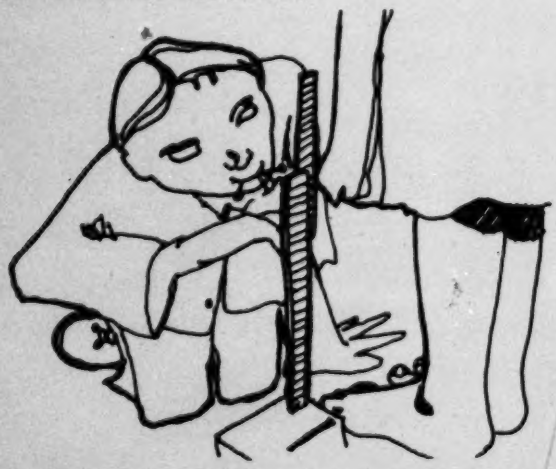
| centimetres cm | millimetres mm |
|---|---|
| | 26 |
| | 45 |
| | 240 |
| 16 | |
| 36.7 | |
| 7.0 | |
| | 192 |
| | 4 |



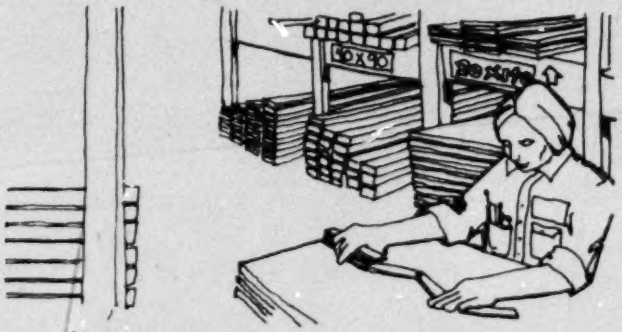
## Metrics at Work

Plumbers use millimetres in their work. Here we see a picture of a plumber measuring the diameter of a pipe in millimetres. Before another pipe will fit the one being measured, the plumber must measure the pipes to see if they are the right sizes.

Clothing hems are also measured in millimetres. In this picture, a tailor is preparing to hem a dress and is measuring the hem in millimetres.



Small objects are not the only things that are measured in millimetres. The carpenter is looking over a supply of lumber. One set of boards is 40 mm by 90 mm and another set of boards is 20 mm by 140 mm. Sheets of plywood, paneling, and plasterboard are 1 200 mm by 2 400 mm. Most doors are 2 100 mm high.



Carpenters, metal workers, construction people, and machine shop workers often read blueprints. One advantage of the metric system is that there are no fractions. People, using blueprints with all dimensions given in millimetres or metres, will find them easier to read. It is important that the person making the drawings knows the metric system so that the drawings are correct.

## KILOMETRES

So far we have worked with the metre and with smaller parts of the metre--the centimetre, and the millimetre. One unit larger than a metre is commonly used. This unit is the kilometre. There are 1 000 metres in a kilometre. The symbol km is used for kilometre.

## Metric Activities

### Activity 17. STEPPING KILOMETRES

How far is a kilometre? Remember Activity 5 (STEPPING METRES) where you stepped off 10 metres? If each step is one metre, then 1 000 steps would be one kilometre. Step off some distances and see if they are a kilometre. How far is it around your block? How far is it from class to where you live? Walk to several places from where you live. Count the steps and then write the distance in kilometres. Is there any place that is exactly one kilometre?

As you walk, count the number of steps.

1 000 steps is 1 000 metres, or 1 km;

2 000 steps is 2 000 metres, or 2 km;

3 000 steps is 3 000 metres, or 3 km;

4 000 steps is 4 000 metres, or 4 km;

and so on.

What about 500 steps? This is 500 m, or 0.5 km (five-tenths of a kilometre). What if you walk 1 500 steps? This is the same as 1 500 m, or 1.5 km.

2 500 steps is 2 500 m, or 2.5 km;

3 600 steps is 3 600 m, or 3.6 km;

5 320 steps is 5 320 m, or 5.320 km;

6 784 steps is 6 784 m, or 6.784 km;

and so on.

Complete the following table to get a better idea of how to change metres to kilometres or to change kilometres to metres. After you have completed the table check your answers with the answers on page 59.

| steps | metres | kilometres |
|---|---|---|
| 6 000 | | |
| 12 000 | | |
| 8 500 | | |
| | 4 500 | |
| | 32 400 | |
| 6 780 | | |
| | | 5.8 |
| | | 4.92 |
| | | 0.4 |
| 6 937 | | |
| | 8 394 | |
| | | 38.693 |

Activity 18. SCALING KILOMETRES

Before people take a trip they often need to know the distance they will travel. To do this they may use a map. There are many kinds of maps but all of them show distances to scale.

This map shows four cities. In the bottom left corner of the map is the scale. It is 1 cm = 1 km. This means that each centimetre on the map is the same as 1 kilometre in real life.

Measure the distance from A to B. (Measure from the dot inside circle A to the dot inside circle B.) Did you get 14 cm? How many kilometres is it? Your answer should be 14 km.

What if the distance does not measure an exact number of centimetres? Then you will have to use the fact that 1 mm = 0.1 cm. So, if the distance on the map from A to D is 145 mm this would be the same as 14.5 cm, and so the distance from A to D is 14.5 km.

Now find each of the following distances. Be sure that you follow the roads. Write your answers on a sheet of paper.

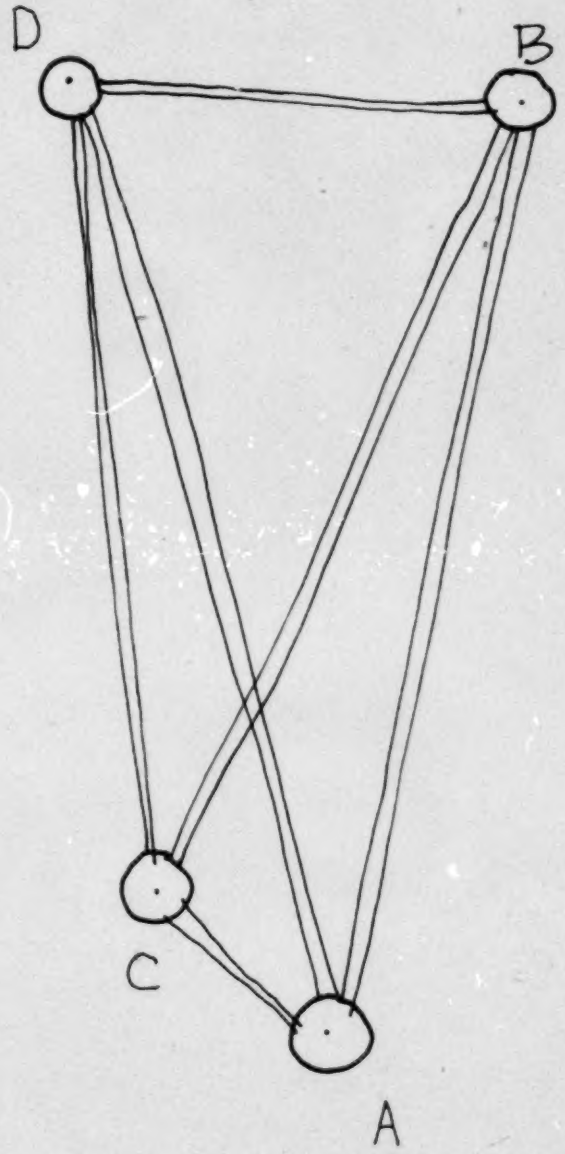
A to C

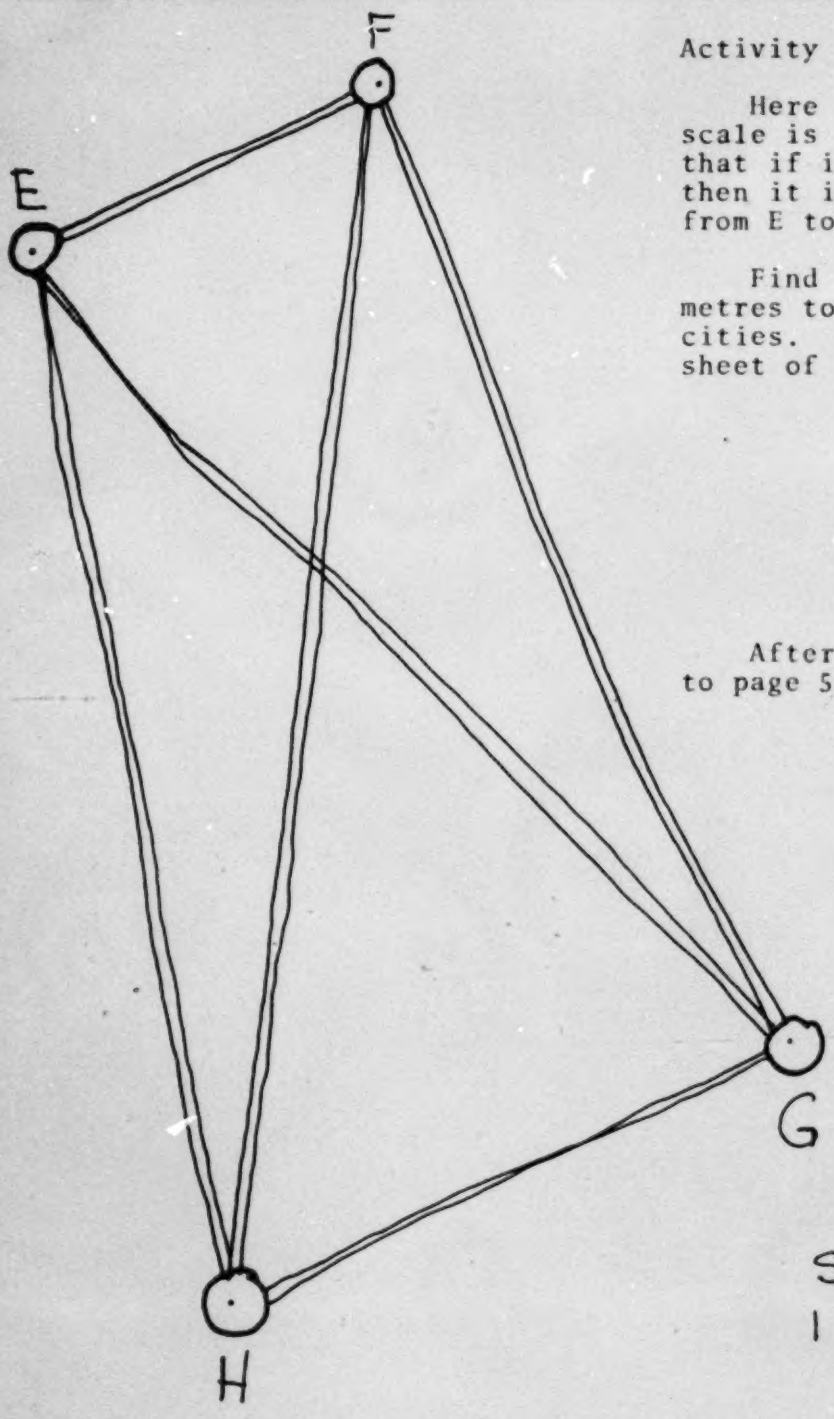
B to D

C to D

B to C

After you have finished, turn to page 59 and check your answers.






SCALE
1 cm = 3 km

## Activity 19. MORE SCALES

Here is another map. The scale is 1 cm = 3 km. This means that if it is 5.6 cm from E to F then it is 3 km × 5.6 = 16.8 km from E to F.

Find the distance in kilometres to each of the following cities. Write your answers on a sheet of paper.

E to G

F to G

G to H

H to F

After you have finished, turn to page 59 and check your answers.

## Activity 20. CROSS COUNTRY

Here is a map of the United States. The scale on this map is 1 cm = 300 km. That means that if the distance between two cities on the map is 5 cm, then the real distance between those two cities is 5 x 300 km, or 1 500 km. This is the shortest distance between these two cities--the distance an airplane might travel, not the distance a car would travel.

Find the distance in kilometres between each of the following cities. Write your answers on a sheet of paper.

New York and Los Angeles

Boise and St. Louis

New York and Boston

Chicago and Atlanta

Dallas and Boston

Los Angeles and Seattle

Denver and Chicago

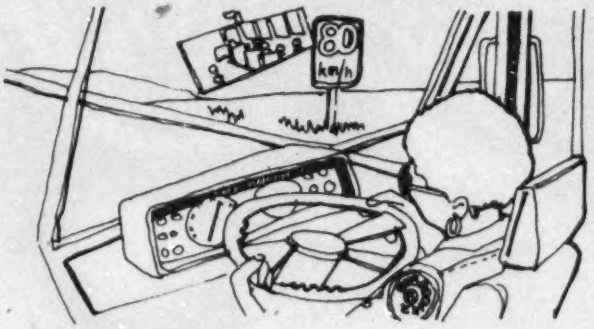
After you have finished, turn to page 59 and check your answers.

## Metrics at Work

Before people can have a map to read someone has to make the map. A cartographer, or map maker, has to know the distance from one place to another. This distance must be changed to the distance according to the scale before the map can be made.

Along the highway there are signs that tell how far it is to the next city. The sign in this picture says that it is 15 kilometres to Downtown. Some signs will have the word kilometre written out and other signs will use the symbol km. The sign in the picture uses the symbol km and so the sign says that it is 15 km to Downtown.

When we want to know how far it is to a city we give that distance in kilometres. When we want to know how fast a car is going we give the speed in kilometres per hour. The symbol km/h is used for kilometres per hour.




Here is a picture of a bus driver driving her bus down the highway. The sign says that the speed limit is 80 km/h, or 80 kilometres per hour. The speedometer tells how fast the bus is going.

Who else needs to know the number of kilometres it is from one place to another? Truck drivers, pilots, police, traveling salespeople, fire fighters, taxi drivers, and anyone who travels needs to know distances in kilometres. See how many other jobs you and your class can think of where people need to use kilometres.

## KILOMETRES TO METRES TO CENTIMETRES TO MILLIMETRES

We have looked at four units that are used to measure length, width, height, and depth. Sometimes we need to know how to change from one unit to another. We have already changed metres to kilometres, millimetres to centimetres, and kilometres to metres. Now let's look at some other changes.

We know that there are 100 centimetres in one metre. Thus,

2 m = 2 x 100 cm = 200 cm,

3 m = 3 x 100 cm = 300 cm,

8 m = 8 x 100 cm = 800 cm,

36 m = 36 x 100 cm = 3 600 cm.

Also, since there are 1 000 mm in one metre, then

2 m = 2 x 1 000 mm = 2 000 mm,

6 m = 6 x 1 000 mm = 6 000 mm,

25 m = 25 x 1 000 mm = 25 000 mm,

and so on.

From your work with decimals you know that

one-half of a metre can be written 0.5 m,

one-fifth of a centimetre can be written 0.2 cm,

one-fourth of a kilometre can be written 0.25 km.

This means that if you wanted to change three-fourths of a kilometre (0.75 km) to metres, you would mulitiply by 1 000. So,

0.75 km = 0.75 x 1 000 m = 750 m.

Fill in the chart below. After you have completed the chart, turn to page 59 to check your answers.

| kilometres km | metres m | centimetres cm | millimetres mm |
|---|---|---|---|
| 1 | 1 000 | 100 000 | 1 000 000 |
| 2 | 2 000 | 200 000 | 2 000 000 |
| 3 | 3 000 | | |
| 4 | | 400 000 | |
| 5 | | | |
| 12 | | | 12 000 000 |
| 0.5 | 500 | | |
| 1.5 | | 150 000 | |
| 8.3 | | | 8 300 000 |
| 0.05 | 50 | | |
| 0.08 | | 8 000 | |
| 0.009 | | | 9 000 |
| | | 650 | |
| | 4 | | |
| | 0.8 | 80 | |
| | | 2.5 | 25 |
| | | | 148 |
| | | 639 | |
| | | 0.3 | |
| | 0.094 | | |
| | 5.786 | | |
| | 8.940 | | |
| | | 13.7 | |
| | | | 4 786 |

Complete the problems here. You may want to use the chart that you just finished. When you are done with the problems, turn to page 60 in order to check your answers.

a) 3.407 m = ____ cm

b) _____ cm = 4.85 m

c) 3.021 m = ____ mm

d) _____ cm = 0.7 m

e) 25 km = ____ m

f) 1 784 m = ____ km

g) ____ km = 3 582 m

h) 45 cm = ____ mm

i) 650 cm = ____ m

j) 5.4 km = ____ m

k) 4 832 mm = ____ m

l) 8 639 mm = ____ cm

m) 385 m = ____ km

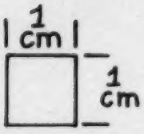
n) 74.3 cm = ____ mm

o) 0.75 m = ____ cm

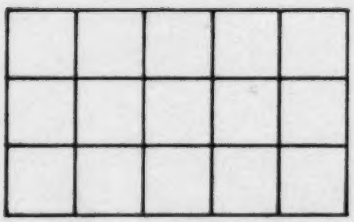
## SQUARE CENTIMETRES

In the metric system, area is usually measured in square metres and square centimetres. The symbols are

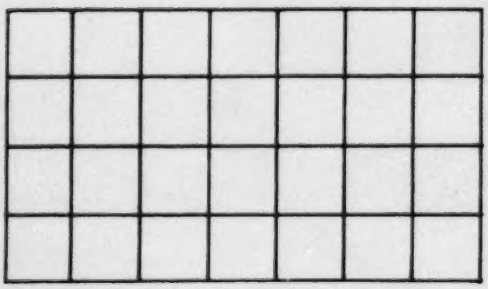
square metre ($m^2$),
square centimetre ($cm^2$),




This is a square centimetre. It measures 1 cm by 1 cm.



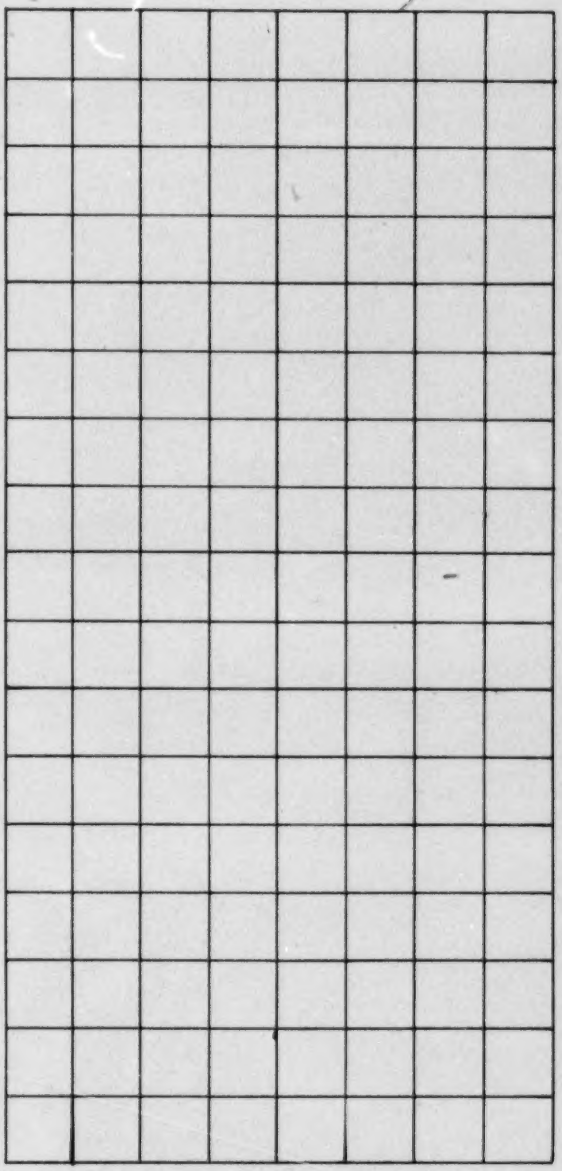
The rectangle here measures 5 cm by 3 cm. It is divided into square centimetres. How many square centimetres are there in this rectangle? Count them and you should get 15. The area of the rectangle is 15 square centimetres (15 $cm^2$).



Look at the next rectangle. It is 4 cm by 7 cm. What is the area of this rectangle? There are two ways to find out. One way is to count the number of squares. Another way is to notice that there are four rows with seven square centimetres in each row, or $\underbrace{7 + 7 + 7 + 7}_{4 \times 7}$ $cm^2$. Both ways you should get 28 $cm^2$. Area is always given in square units so don't forget to use the correct symbol.

Here is a third rectangle. This rectangle is 17 cm by 8 cm. What is the area of this rectangle? You could count the number of square centimetres, but that would take a long time. An easier way to find the area is to see that there are 8 rows with 17 $cm^2$ in each row. This is a total of

$$\underbrace{17 + 17 + 17 + 17 + 17 + 17 + 17 + 17}_{8 \times 17} = 136 \text{ cm}^2$$



## SQUARE METRES

Some people such as wallpaper hangers and carpet salespersons use square metres in their work. This is a much larger unit than a square centimetre. How big is a square metre? You will get an idea of its size in the Metric Activities that begin on the next page.

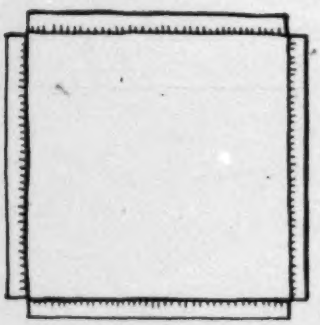
## FIND THE AREA

The lengths and widths of some rectangles are given below. Find the area of each of these rectangles. When you have finished, check your answer with the ones given on page 60.

| Length | Width | Area |
|---|---|---|
| 4 m | 6 m | |
| 8 cm | 2 cm | |
| 25 cm | 17 cm | |
| 5.2 m | 9 m | |
| 4.3cm | 20 cm | |
| 18 m | 150 cm | |
| 270 cm | 1.6m | |

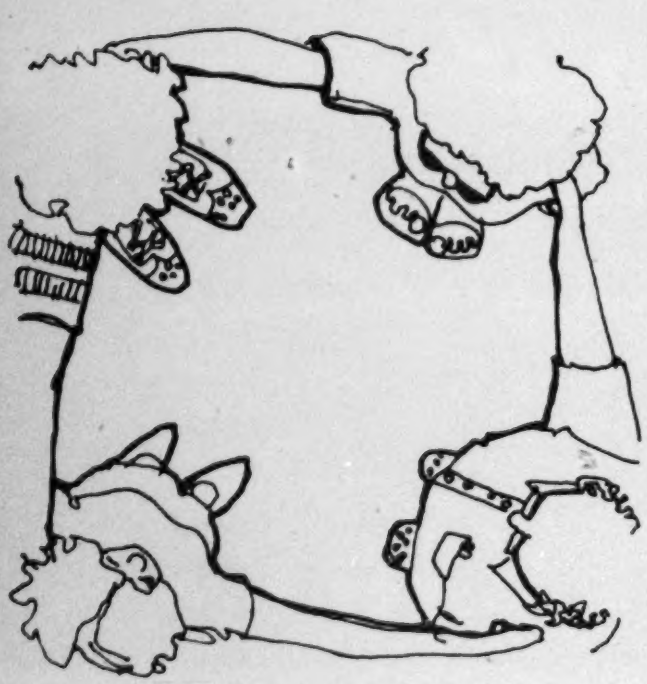
## Metric Activities

### Activity 21. SQUARE METRES



Get together with three other people so that you form a group of four. Take four metre sticks and form a square. Put the sticks together so that they touch only at the corners. When you have finished, the square should look something like the one pictured here. The space inside this square is one square metre. Look around the room. Do you see anything that looks as if it has an area of one square metre?

### Activity 22. LIVING METRES



Do you remember how long a metre is? You and your three partners get together again. Stand facing each other, and form a square. Hold your right arm out straight at shoulder length. Touch yourself with your left hand so that the length from the end of your right hand to your left hand is one metre. Have the partner on your left touch you with her right hand at the place where you have your left hand. You touch the partner on your right with your right hand where he has his left hand. Keep going until every partner is touching another partner. Now look at the space the four of you have formed. This space should be a square metre.

## Activity 23. METRIC ROOM

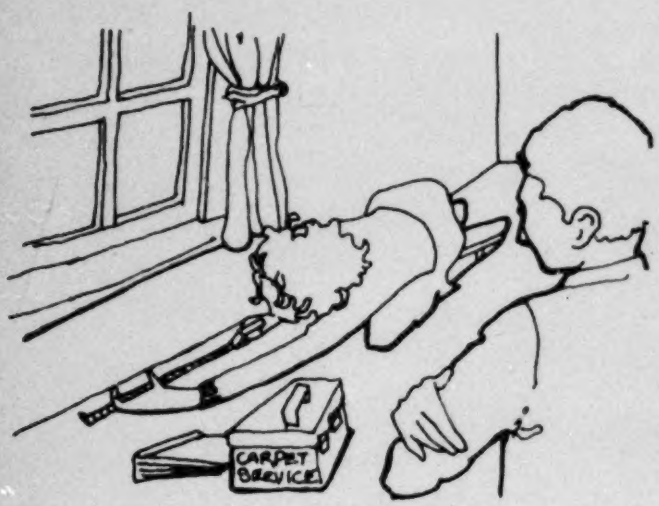
In Activity 4 (METRE ROOM) you measured the length and width of the room in metres. What is the area of the floor in square metres? How many square metres of floor tiles would it take for this room? If each box of floor tile contains about 4 $m^2$, how many boxes of tile would it take to cover the floor of this room? (Since you will not be able to buy part of a box of tile, your answer should be a whole number. If you find that it will take 4.2 boxes then your answer will be that it will take 5 boxes. Always count a part of a box as a whole box when you figure out how much tile it will take.) Check your answer with other students in the class or with your teacher.

You also measured the height of the room. Find the area of each wall in square metres. Find the total area for all the walls in the room. If a can of paint covers 30 $m^2$, how many cans of paint would it take to give the walls one coat of paint? Two coats of paint? (What did you do about the windows and the doors? Did you subtract their area when you found the area of a wall? If you didn't, you probably better check your work.) Check your answers with some of the other students in class or with the teacher.

### Metrics at Work

Where do people use square metres in their work? Here are some ways in which people use square metres on the job.

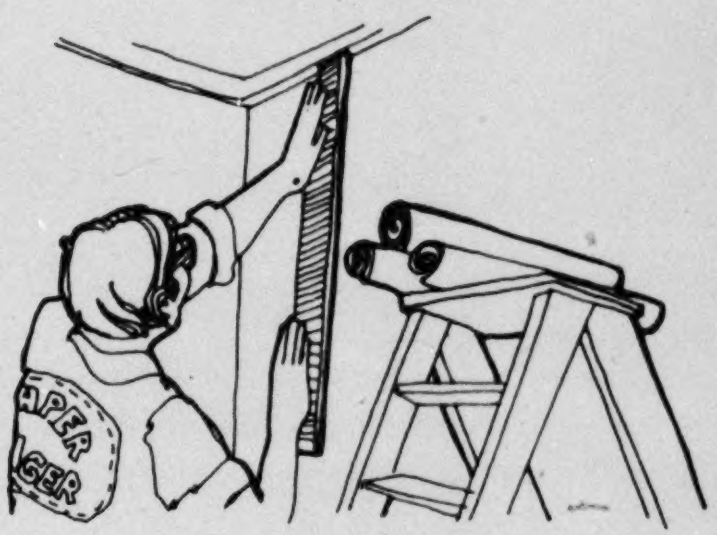
People who sell carpets and floor tiles use square metres. In the first picture, the sales clerk is helping someone pick out a carpet. The price of the carpet is $9.00 for each square metre ($9/$m^2$). Before the clerk can finish the sale she needs to know how much carpeting will be needed. One way to do this is to work from a blueprint or a scale drawing of the place to be carpeted. Another way is to measure the floor space that is to be carpeted.

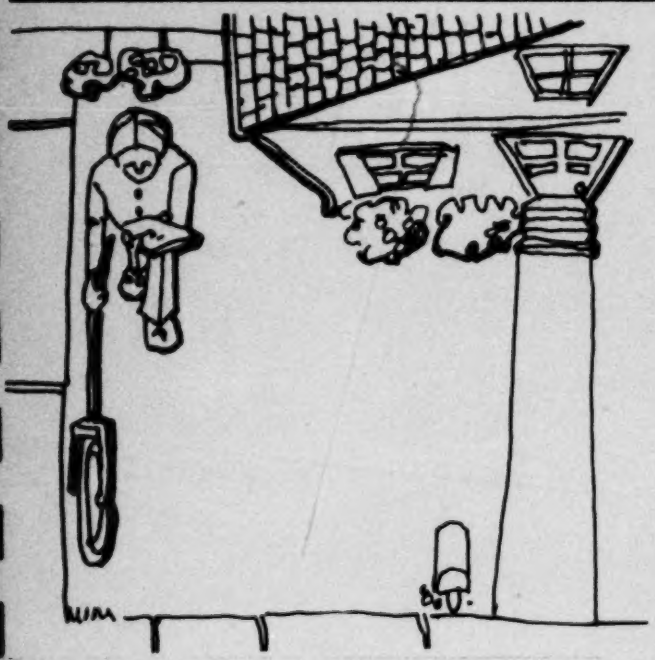



In the second picture the sales clerk has gone to measure the room. If the room is a rectangle, then all she needs to do is measure the length and width of the room. From these measurements she can find the area of the room in square metres.

What if the room is not a rectangle? What if there is a closet to carpet? What changes will have to be made when she figures the amount of carpet that will be needed?

Other people use square metres when they work. For example, this wallpaper hanger is measuring the wall so he will know how many rolls of paper to order. Rolls of wallpaper come in many widths, but each roll has the same number of square metres of wallpaper. Paper hangers need to be able to determine the area of the walls in square metres.



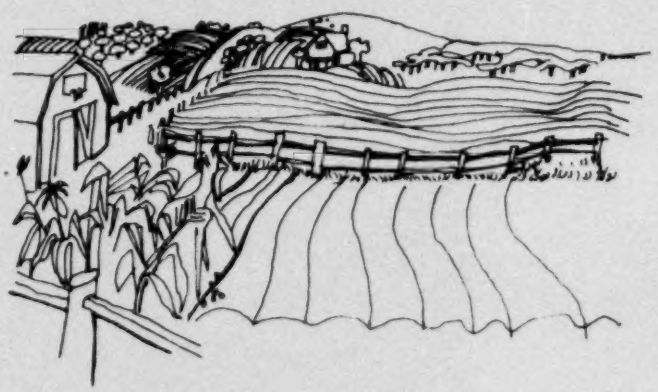


This salesperson is finding the area of a lawn so that the customer will have an idea of how much it will cost to fertilize the the lawn. Notice that a trundle wheel is being used to find the length and width of the lawn. Once the lawn area has been determined, the amount of fertilizer and the cost can be figured.

## HECTARES AND SQUARE KILOMETRES

There are even larger units for area than the square metre. One of these units is the hectare. A hectare is 10 000 $m^2$ and is used for measuring land. The farm land in the picture would be measured in hectares. The symbol for hectare is ha. You may think that this is a funny symbol, but to a farmer it is no laughing matter.

An even larger unit of area is the square kilometre. A square that is one kilometre on each side is a square kilometre. Each square kilometre contains 1 000 000 $m^2$. The symbol for square kilometre is $km^2$. Where would you ever use such a large unit as a square kilometre? Square kilometres are used in finding the area of a city, a state, or a country.



# VOLUME AND CAPACITY

You often need to know how much something holds or how much room it takes up. When you cook you need to know how much to use of each item. When you paint you need to know how much paint to buy. You need to know how much oil or gasoline to put in your car. In this section we are going to see some ways that people measure how much something holds or how much room it takes up.

In the metric system, volume is usually measured in

cubic centimetres (cm³),

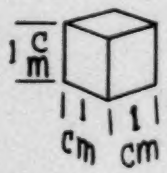
cubic metres (m³),

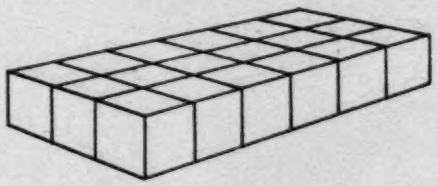
litres (l),

millilitres (ml).

CUBIC CENTIMETRES

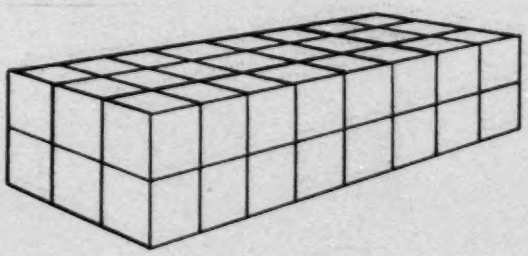
This is a cubic centimetre. It measures 1 cm by 1 cm by 1 cm.



This box is made up of cubic centimetres. The box measures 6 cm long, 3 cm wide, and 1 cm high. How many cubic centimetres are there in this box? Count them and you get 18. So, the volume of the box is 18 cubic centimetres (18 cm³).

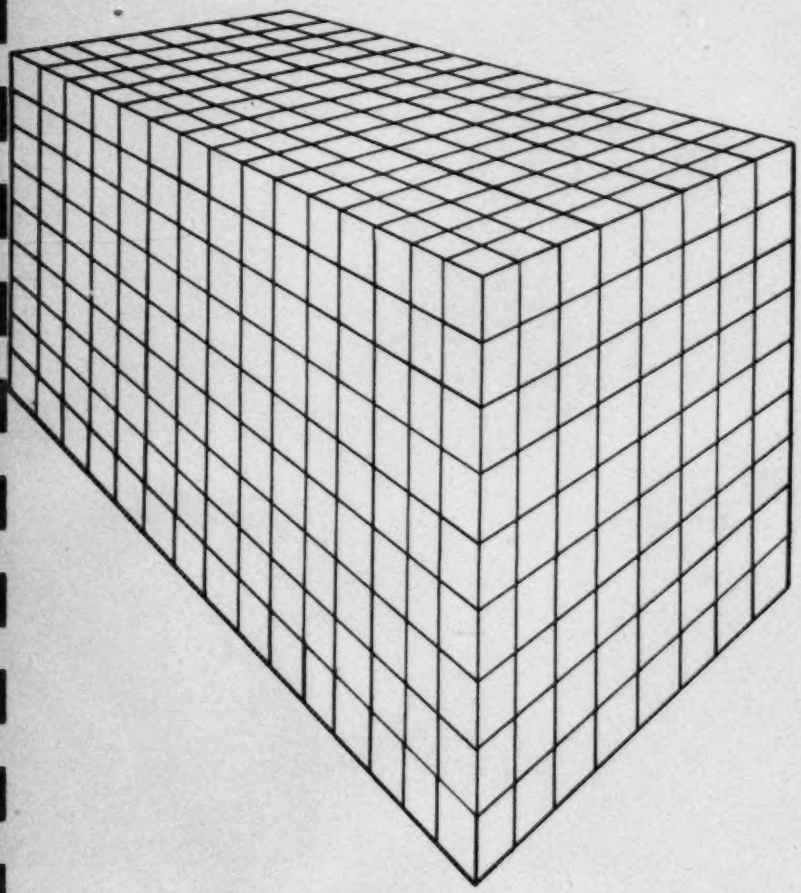
Look at the next box. It is 8 cm long, 3 cm wide, and 2 cm high. What is the volume of this box? There are two ways to find out. One way is to count the number of cubes. This is not always very easy to do. Another way is to count the number of cubes on the top layer, and then multiply this number by the number of layers.



In the box in the picture there are 24 (8 x 3) cm³ in the top layer. There are two layers, for a total of 2 x 24 cm³ = 48 cm³. This is the same answer you would have gotten if you had multiplied the length (8 cm) by the width (3 cm) by the height (2 cm).

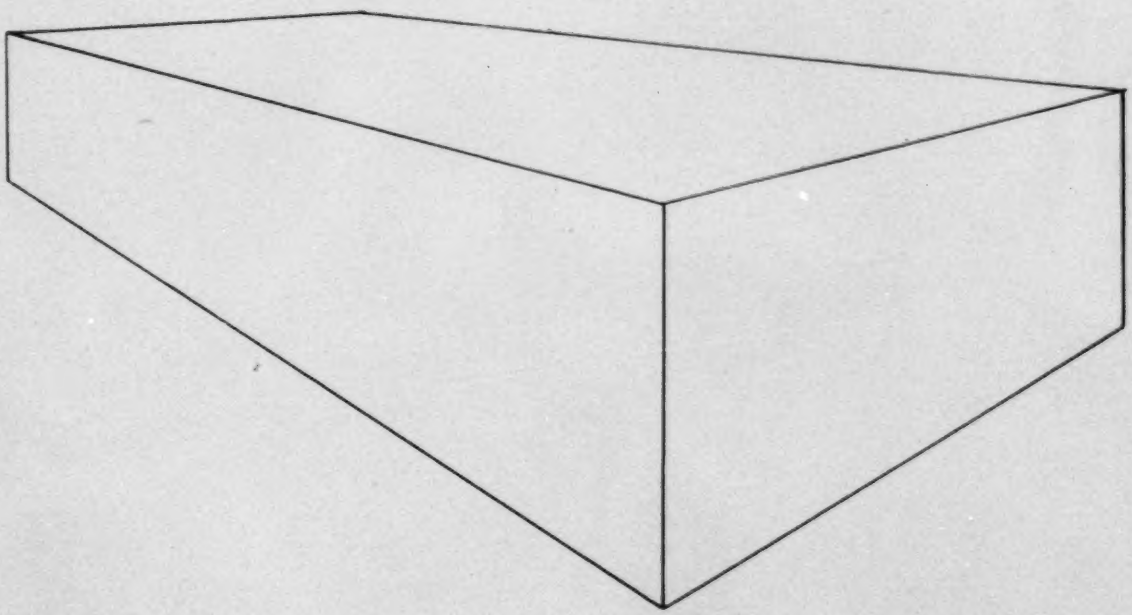
In the third example there is a box that measures 15 cm long, 8 cm wide, and 9 cm high. What is the volume of this box?

The top layer measures 15 cm by 8 cm for a total of 120 $cm^3$. There are 9 layers, so there is a total of 9 × 120 $cm^3$ = 1 080 $cm^3$ in the box. Thus, the box has a total of 1 080 cubic centimetres.



Let's look at a final example. In this example there is a box that measures 14 cm long, 9 cm wide, and 6 cm high. What is the volume of this box?

To find the number of cubic centimetres it takes to cover the bottom layer of this box, we would multiply 14 × 9. Since 14 × 9 is 126, we know that there are 126 cubic centimetres in the bottom layer. How many layers are there? The box is 6 cm high so there are 6 layers with 126 cubic centimetres in each layer. This gives a total of 126 × 6, or 756 cubic centimetres. The volume of this box is 14 cm × 9 cm × 6 cm, or 756 $cm^3$.



## Metric Activities

### Activity 24. CUBIC CENTIMETRES

On the resource table are some rectangular solids (boxes, blocks, brick, and so on) and some metric rulers. What is the volume of each solid in cubic centimetres? Check your answers with your classmates or your teacher.

### Activity 25. ROCKY VOLUME

On the resource table is a watertight rectangular box and a rock. Measure the length and width of the inside of the box. (Try to make these measurements with your metric ruler. You may need an inside caliper or a circle compass to help get these inside measures.) Put enough water in the box so that it will cover the rock--but don't put the rock in the water yet. Measure the height of the water, and determine the volume of the water that is in the box.

Now gently put the rock in the box and measure the height of the water. Find the volume of the water and rock together. What is the volume of the rock? Check your answer with your teacher.

### Activity 26. APPLE VOLUME

Find the volume of an apple. You can do this in the same way that you found the volume of the rock in Activity 25. There is one difference--the apple will float. With your pencil, gently push the apple under water. Push it in just far enough so that the top of the apple is just under the top of the water.

## Metrics at Work

Who uses cubic centimetres in their work? When doctors and nurses give you shots, they measure the amount in cubic centimetres. Sometimes you will hear doctors or nurses say that they want so many c.c.'s of something. When they say this, they mean that they want so many cubic centimetres. Even though the term is not correct, it is in common use.

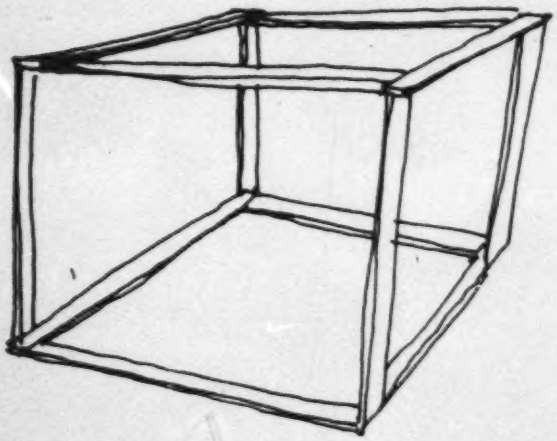
## CUBIC METRES

Many people use a much larger unit--a cubic metre. How big is a cubic metre? Who uses cubic metres? You will get some idea about the size of a cubic metre in the following Metric Activities section. After you have finished the activities, you will get some idea about the kinds of jobs where people use cubic metres.

Metric Activities

Activity 27. CUBIC METRES

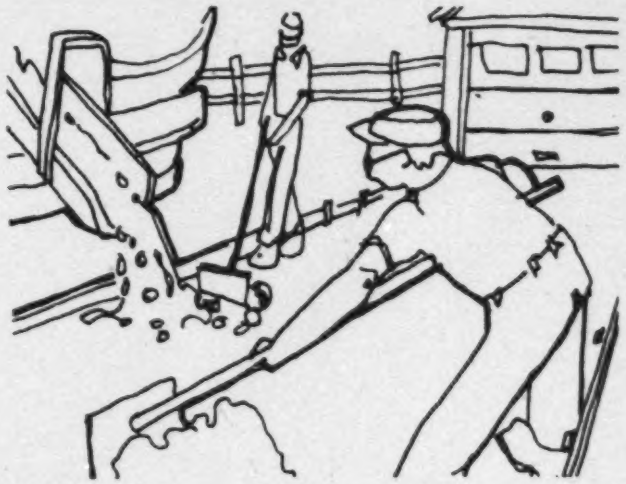
Get together with at least three other people. You will need 12 metre sticks. Make a square metre in the same way as in Activity 21. At the inside of each corner hold a metre stick upright. Put a metre stick across each pair of adjacent corners. When you are done you should have a cubic metre that looks like this picture.



Look around the room. Do you see anything else that seems to be about this same size? If this was a box that had a volume of one cubic metre, what things in the room would fit in the box and what things would not fit?

Activity 28. CUBIC METRE ROOM

In Activity 4 (METRE ROOM) you measured the length, width, and height of the room in metres. What is the volume of this room in cubic metres? Check your answer with your teacher.



Metrics at Work

One place where people use cubic metres is in the concrete business. Here is a picture of a driveway being poured. The amount of concrete that is needed for this driveway was measured in cubic metres. The driveway is 3 m by 20 m by 0.1 m. How many cubic metres of concrete are needed for this driveway? If concrete costs $38.50 a cubic metre, what is the cost of the concrete for this driveway? (Answers on page 60.)

## LITRES

A third unit for volume is the litre. The symbol l (el) is used for litre. If you have 25 litres, you write 25 l. Make sure that you put the space between the numerals and the symbol. If you don't it will look like 25l and not 25 l. Because there can be this confusion, some people think that we should use a different symbol for litre. If you think that someone might not know what you mean, then write the entire word litre.

We measure liquids by pouring them into measuring cups. Salt, sugar, and flour also are measured in the same way. Some items we buy come in pre-measured containers and these containers come in different sizes. Each size tells us how much the container holds, and we buy the size that we need. Containers are often in litre sizes.

A litre is 1 000 cubic centimetres. Just how big is this? The Metric Activities will help you get a feeling for the size of a litre.

## Metric Activities

### Activity 29. LOTS OF LITRES

Go to the resource table. On the table you will find some things that hold one litre. Pick one up, turn it around, and try to get an idea of the size of a litre. Empty the contents into a litre measuring cup. Is it really a litre?

### Activity 30. BOTTLES AND CANS

On the resource table are some bottles and cans of food and drink. Each bottle or can says that it holds one litre. Empty the contents of one of the bottles or cans into a litre measuring cup. Does it really hold a litre? One by one empty each of the other bottles and cans and see if they each hold a litre.

### Activity 31. GUESS LITRES

On the resource table you should find a paper cup, juice glass, soft drink can, casserole dish, frying pan, and a sauce pan. Guess how many litres each of these hold. Write your guesses on a sheet of paper. Now use the litre measuring cup and check your guesses.

### Activity 32. FILL THE BUCKET

Get a bucket and a litre measuring cup. How many litres do you think the bucket will hold? Write everyone's guess on the board.

Fill the measuring cup with one litre of water, and then pour the water into the bucket. Mark the height of the water on the inside of the bucket with a waterproof marker. Fill the cup again; pour the water in the bucket; and make a new mark. Keep doing this until the bucket is full. How many litres does the bucket hold? How close is your guess? Who has the closest guess?

Metrics at Work and at Home

This man is taking a litre of milk out of the refrigerator for his hungry baby. Litres are used to measure large amounts of liquid such as milk, orange juice, tomato juice, and water.

The baker is using a litre cup to measure the sugar for his recipe. When you cook with larger amounts, you use litres or parts of litres. In fact, many of the items you cook with are measured in litres--sugar, flour, rice, and milk are just a few.

This woman is buying some paint. Cans of paint come in one litre, two litre, and four litre sizes. A painter needs to know how many litres of paint to use in order to paint a room or a house.

Some other things that come in litres are gas and oil for your car or truck, soft drinks, beer, and wine.

## MILLILITRES

There are times when a litre is too big. A smaller size for measuring liquids is a millilitre. There are 1 000 millilitres in one litre. The symbol ml is used for millilitre. Thus, you write 37 ml to show 37 millilitres. When you measure in millilitres you will use millilitre spoons, small measuring cups, or litre measuring cups.

## Metric Activities

### Activity 33. SPOONS

On the resource table are some millilitre measuring spoons and some small bottles. Use the spoons to find out how many millilitres each bottle holds. How do you know how much each spoon holds? When would you use millilitre spoons? Talk about some of these times with other students. How many can you name?

### Activity 34. COFFEE BREAK

Make a pot of coffee with the help of the other students in the class. If you have enough coffee drinkers, use 2 litres of water and eight 15 ml spoonfuls of coffee. Use millilitre spoons for the sugar and cream. How many millilitres of sugar do you take in your coffee? How many millilitres of cream? How many millilitres of each did the entire class use?

### Activity 35. CAN CAN

On the table are some cans. How many millilitres does each can hold? Mark your answers on a sheet of paper. If a serving is about 200 ml, how many servings does each can hold? If you were going to prepare a meal for your class, how many cans of each would you need so that everyone has one serving? Two servings?

### Activity 36. SHOPPING TRIP

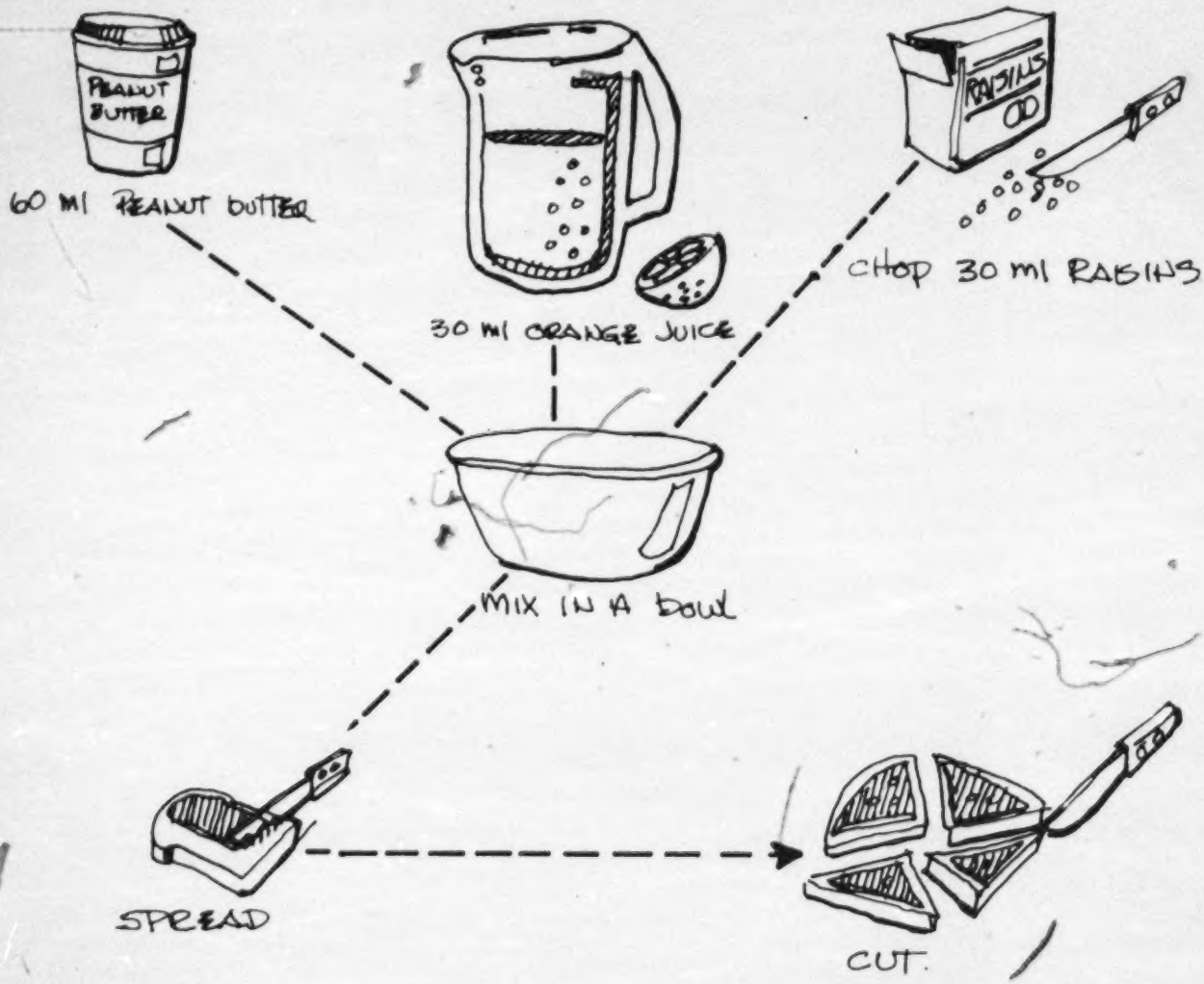
Go to the grocery store and look at the labels on the cans and boxes. How many millilitres or litres does each can or box hold?

Look at the cans and boxes of food that you have at home. How many millilitres or litres does each one hold? Bring some empty cans and boxes (or just bring the labels) to class. Compare the sizes. See how many different items you can find that are marked in millilitres or litres.

### Activity 37. LET'S EAT

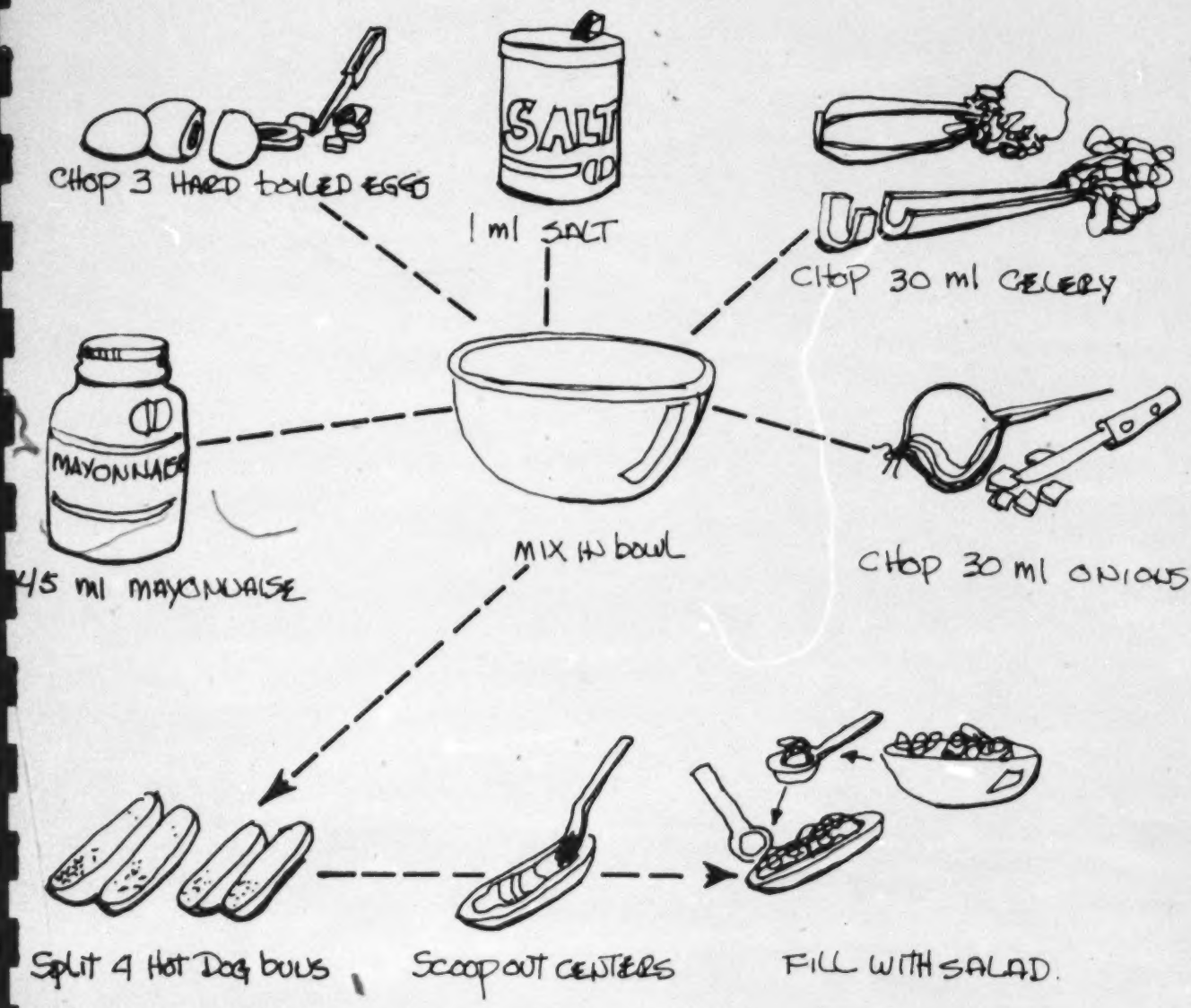
On the next pages are four recipes. With the help of the rest of the class, follow the recipes and prepare enough food for everyone.

## Millispread for Bread



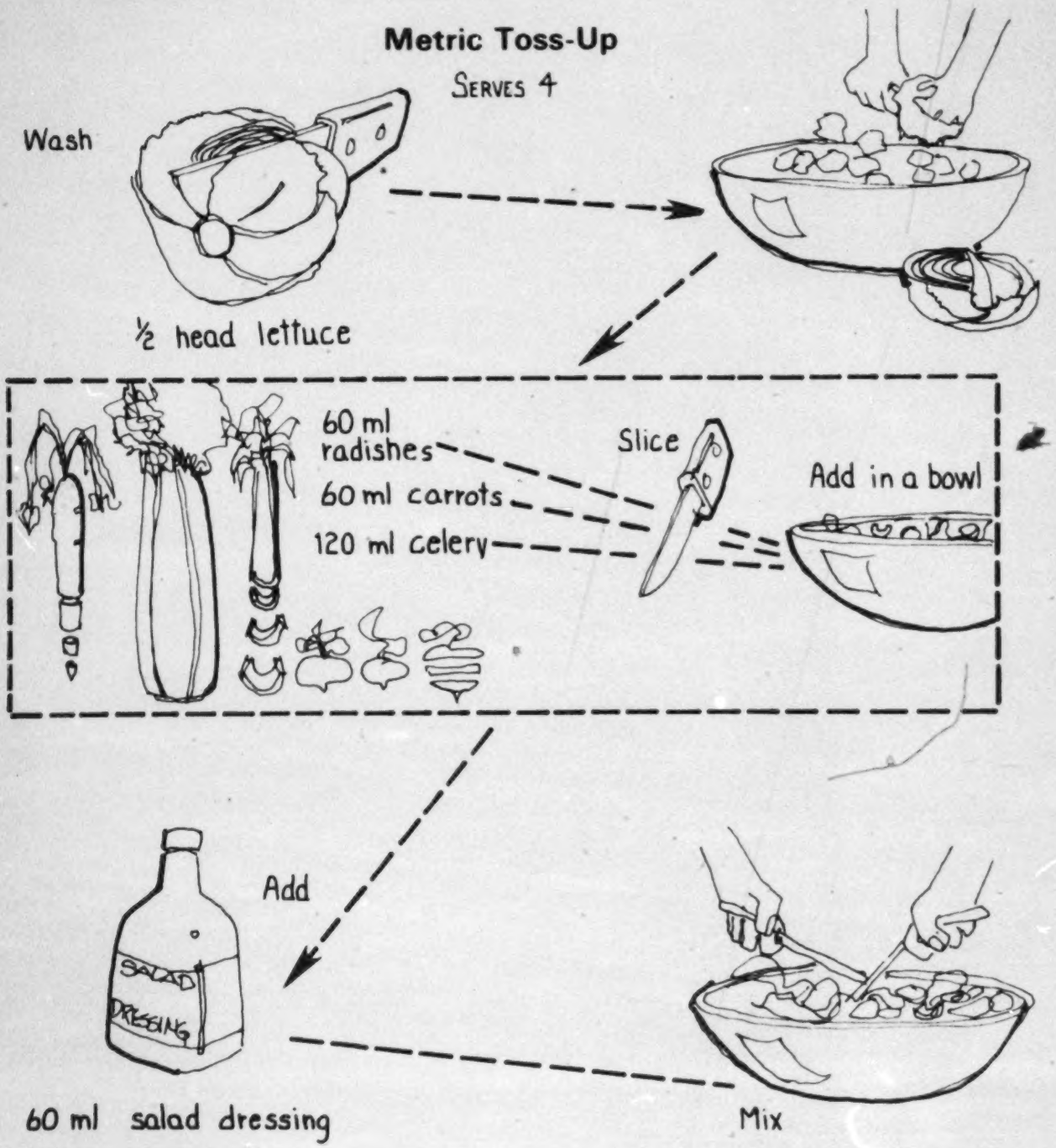
## Metric Egg Salad

MAKES 8 SANDWICHES

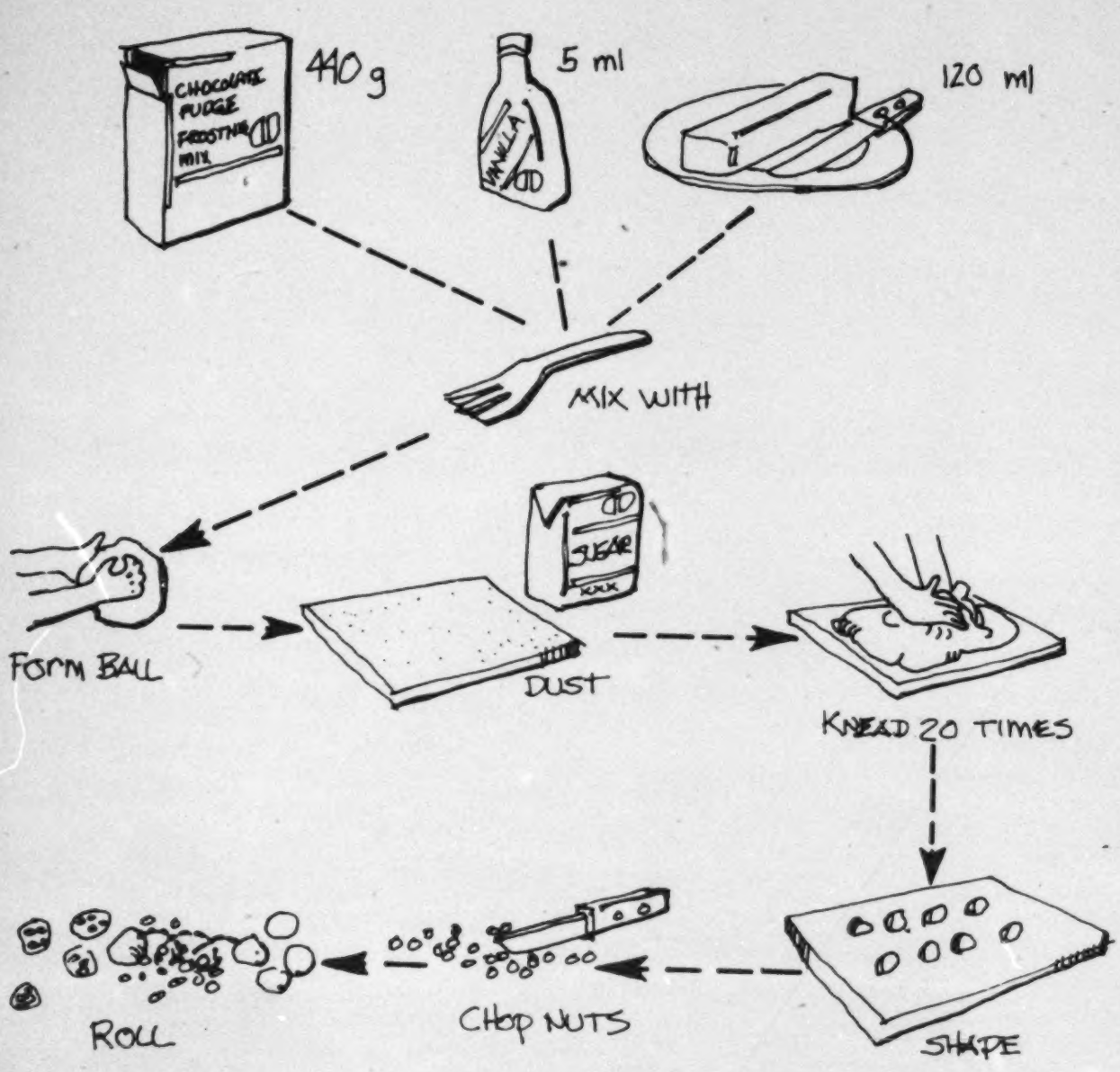


## Metric Toss-Up

SERVES 4



## Fudge Metribites



## Metrics at Work and at Home

The woman in this picture is cooking. She is measuring the amount of salt she needs with a millilitre spoon. What else does she measure in millilitres? Look at the picture. Some of the things in the picture that are measured in millilitres are baking soda, olive oil, and spices.

You use millilitres for more than cooking. The man in this picture is giving his child some medicine. He is using a 5 ml spoon to measure the amount of medicine that is needed.

Some things come in packages that are marked in millilitres. For example, small amounts of milk come in 100 ml and 500 ml sizes; beer comes in 340 ml and 625 ml sizes; and shampoo comes in 25 ml and 50 ml sizes.

One other person who needs to use millilitres at work is a chemistry lab technician. When a person is working in a chemistry lab, small amounts--like millilitres--are very important.

Who else needs to know how to measure in litres or millilitres? See how many other jobs you and the people in your class can name where people need to use litres or millilitres.

## MILLILITRES TO LITRES

There are 1 000 millilitres in one litre. This means that

2 000 millilitres is the same as 2 litres,

3 000 ml is the same as 3 litres,

4 000 ml is the same as 4 litres,

5 000 ml is the same as 5 litres,

12 000 ml is the same as 12 litres,

and so on. As you can see, since there are 1 000 millilitres in each litre, one way to change millilitres to litres is to divide by 1 000. For example,

$$1\ 000 \text{ ml} = \frac{1\ 000}{1\ 000} \text{ litre} = 1 \text{ litre.}$$

Or

$$2\ 000 \text{ ml} = \frac{2\ 000}{1\ 000} \text{ litres} = 2 \text{ litres.}$$

As a final example

$$28\ 000 \text{ ml} = \frac{28\ 000}{1\ 000} \text{ litres}$$

$$= 28 \text{ litres.}$$

Now you try some. Complete the following chart. When you have finished, check your answers with the ones on page 60.

| millilitres ml | litres l |
|---|---|
| 3 000 | 3 |
| 6 000 | |
| 8 000 | |
| 14 000 | |
| 87 000 | |
| 114 000 | |
| | 16 |
| | 63 |
| 274 000 | |
| | 94 |

What if something holds 500 ml? How many litres is this? This is worked the same way as the previous problems.

$$500 \text{ ml} = \frac{500}{1\ 000} \text{ litre}$$

$$= \frac{5}{10} \text{ litre}$$

$$= 0.5 \text{ litre}$$

= five-tenths of a litre.

So, 500 millilitres is the same as 0.5 litre, or 500 millilitres is the same as one-half of a litre.

What about 420 millilitres? Change this to litres.

$$\frac{420}{1\ 000} \text{ litre} = \frac{42}{100} \text{ litre}$$

$$= 0.42 \text{ litre.}$$

Change 57 millilitres to litres.

$$57 \text{ ml} = \frac{57}{1\ 000} \text{ litre}$$

$$= 0.057 \text{ litre.}$$

As a final example, change 4 700 millilitres to litres.

$$4\ 700 \text{ ml} = \frac{4\ 700}{1\ 000} \text{ litres}$$

$$= 4.7 \text{ litres.}$$

Now it is your turn to try some. Complete this chart. When you have finished, check your answers with the ones given on page 60.

| millilitres ml | litres l |
|---|---|
| 300 | 0.3 |
| 700 | |
| 200 | |
| | 0.9 |
| 250 | |
| 870 | |
| | 0.47 |
| 275 | |
| 188 | |
| 869 | |
| | 0.396 |
| 3 300 | |
| 7 400 | |
| | 5.2 |
| 23 800 | |
| 8 760 | |
| | 9.43 |
| 5 839 | |

## LITRES TO MILLILITRES

By now you should be able to change millilitres to litres. What do you do if you need to change litres to millilitres? Let's look at a few examples. Remember, there are 1 000 millilitres in one litre, or 1 litre is the same as 1 000 millilitres. So, 2 litres = 2 × 1 000, or 2 000 millilitres.

How many millilitres are there in 7 litres?

$$7 \text{ litres} = 7 \times 1\,000 \text{ ml}$$

$$= 7\,000 \text{ ml}.$$

So, 7 litres is the same as 7 000 millilitres.

$$13 \text{ litres} = 13 \times 1\,000 \text{ ml}$$

$$= 13\,000 \text{ ml}.$$

Change 0.76 litre (seventy-six hundreths of a litre) to millilitres.

$$0.76 \text{ litre} = 0.76 \times 1\,000 \text{ ml}$$

$$= \frac{76}{100} \times 1\,000 \text{ ml}$$

$$= 76 \times \frac{1\,000}{100} \text{ ml}$$

$$= 76 \times 10 \text{ ml}$$

$$= 760 \text{ millilitres}.$$

Change 0.604 litre to millilitres.

$$0.604 \text{ litre} = 0.604 \times 1\,000 \text{ ml}$$

$$= 604 \text{ ml}.$$

Now you try some. Complete this chart. When you have finished, check your answers with the ones that are given on page 60.

| litres<br>l | millilitres<br>ml |
|---|---|
| 8 | 8 000 |
| 5 | |
| 46 | |
| | 32 000 |
| 0.4 | |
| 0.53 | |
| 0.07 | 70 |
| | 96 |
| 0.583 | |
| 47.639 | |

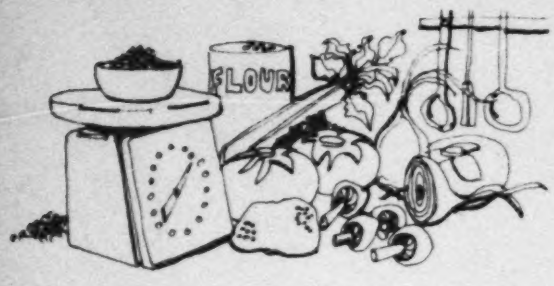
## Metrics at Work

One place where litres are used has not been mentioned. Automobile engine displacements are given in litres. Here is a picture of an auto mechanic working on the motor of a car with an engine displacement of 6.6 litres. What is the engine displacement of this car in millilitres? Check the answers on page 61.

Wine and alcohol come in both litres and millilitres. In this picture a clerk is helping a customer buy some wine. One size bottle that liquor comes in is 1.75 litres. How many millilitres is this? Liquor also comes in 1 litre bottles, 750 ml bottles, and 500 ml bottles. Complete this chart to compare these sizes in litres and in millilitres. Check your answers on page 61.

| litres<br>l | millilitres<br>ml |
|---|---|
| 1.75 | |
| 1 | |
| | 750 |
| | 500 |

# MASS




In this picture you see a scale. A scale is used to measure the weight, or mass, of things. When people buy some of the foods in the picture, they buy them by weight or mass.

The mass of an object is a measure of the amount of matter in the object. This amount is always the same unless you add or subtract some matter from the object. Weight is the term that most people use when they mean mass. The weight of an object is affected by gravity; the mass of an object is not. For example, the weight of a person on earth might be 120 pounds; that same person's weight on the moon would be 20 pounds. This difference is because the pull of gravity on the moon is less than the pull of gravity on earth. A person's mass on the earth and on the moon would be the same. The metric system does not measure weight--it measures mass. For the rest of this workbook we will use the term mass.

## KILOGRAMS

The basic unit for mass is the kilogram. Kilograms are used to find the mass of heavy things. The symbol for kilogram is kg and so you would write 48 kg for 48 kilograms.

## Metric Activities

Activity 38. FIND YOUR MASS

Use the bathroom scale to find your mass. What is your mass in kilograms?

Activity 39. KILOGRAMS

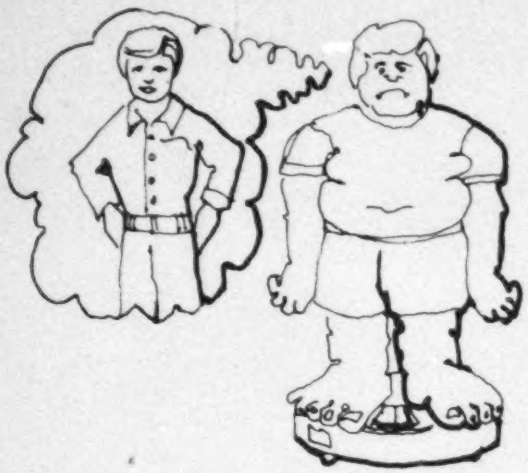
Pick up one of the kilogram mass pieces on the resource table. Shift it around in your hand until you get a feeling for its mass. Pick up two kilogram mass pieces in the other hand. Can you tell that the mass that you are holding in one hand is more than in the other hand?

Activity 40. WHAT'S ITS MASS?

Pick up some of the heavy objects on the resource table. Guess the mass of the brick and write your guess on a sheet of paper. Guess the mass of the box of rice; write your guess on a sheet of paper. What is the mass of the apple? After you have written your three guesses on a sheet of paper, use the kilogram scale to find the mass of each object. How close was each guess to the real mass?

## Metrics at Work

What are some of the things whose mass you might want to find? What are some jobs where you need to find the mass of things? As you look at the examples that follow, think of some other things and places where you would use mass.



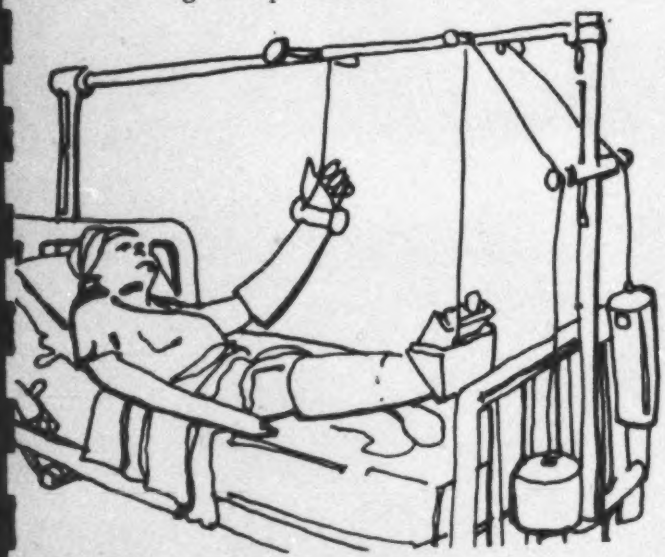
Here is a picture of a man standing on a scale. He is not very happy. His mass is too much. (You might say that he is massive!) He keeps thinking of what he will look like if he can lower his mass.

In the next picture a group of army recruits are having their masses measured in kilograms. An average woman has a mass of 50 or 55 kilograms. An average man has a mass of about 80 or 90 kilograms. A heavyweight boxer has a mass of around 100 kilograms.

What else besides the mass of people is given in kilograms? Look at the picture of the grocery store. Here is a clerk making a display of cans of coffee. Each can has a mass of 1 kg. What else in the picture is in kilograms: sugar, flour, and potatoes are some of the things in a grocery store that come in kilograms.

When people buy nails, they often buy them by the kilogram. In this picture, a person is buying 2 kg of nails. The hardware store clerk is measuring 2 kg of nails on the kilogram scale. What else do you see in the hardware store that can be measured in kilograms?

Sometimes when people are injured, they have to be put in traction. Here you see a picture of a person in traction. The amount of tension can be changed by either adding or subtracting some kilogram pieces.



GRAMS

We often want to find the mass of something that is less than one kilogram. The mass of the apple is probably less than one kilogram. In order to measure the mass of something lighter than a kilogram we need to have a unit of mass that is smaller than a kilogram. The unit that is usually used is the gram. The symbol g is used for gram. There are 1 000 grams in one kilogram.

Metric Activities

Activity 41. GRAMS, GRAMS, GRAMS

Go to the resource table and pick up a 1 g (1 gram) mass piece. Put 2 g in your other hand. Can you tell the difference? Put these mass pieces back on the table.

Get a partner, close your eyes, and have your partner put 5 g in one of your hands and 10 g in the other hand. Can you tell which hand has the 5 grams and which has the 10 grams? With your eyes closed have your partner put some mass pieces in one hand. Can you guess the mass of the pieces you are holding? Your partner should take those pieces from your hand and put some different mass pieces in your hand. Try to guess the mass of these new pieces. Keep trying until you become fairly good at guessing the correct mass.

Trade places with your partner and put the mass pieces in your partner's hand. Have your partner guess the mass of the pieces.

Activity 42. GUESS AND FIND THE MASS

On the resource table are some small objects: paper clip, nickel, sugar cube, pencil, sunglasses, and metric ruler. Guess the mass of each object. Write your guesses on a sheet of paper. (Remember to use g for grams when you write your guess.) Now find the exact mass of the objects. How close are your guesses? Find some other things; guess their masses; then measure their masses.

Activity 43. WHAT WE EAT

Find the mass of some boxes, cans, and sacks of food. Many food containers print the mass on the container. Look at both light and heavy items. If it is possible, bring some of the foods to class. Empty a box, can, or sack and find the mass of the contents. Is the label correct?

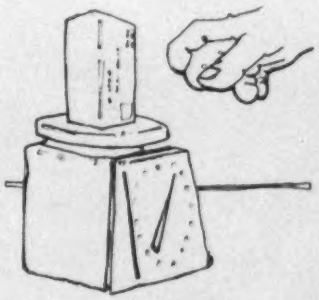
Activity 44. THINK MASS

Do you know anyone who works with mass on the job? Do they use a gram scale or a kilogram scale? What other jobs are there where the masses of things are measured? Talk about it with other people in the class and see how many you can name.

Using Metrics at Work and at Home

Who uses grams? This person is a child care aide who often has to buy paint and other supplies in powdered form. In the picture the aide is mixing some paint. The paint comes in a 250 g container. What else do you see in the picture that might be measured in grams?

When you go to the post office to mail an envelope or a small package, the postal clerk will find its mass in grams. A gram scale is used to find the mass. If you bring a heavy package to the post office, the postal clerk may use a kilogram scale. Post office workers need to know how to use both a kilogram scale and a gram scale.



## GRAMS TO KILOGRAMS

There are 1 000 grams in one kilogram. This means that

2 000 grams is the same as 2 kg,

3 000 grams is the same as 3 kg,

4 000 g is the same as 4 kg,

5 000 g is the same as 5 kg,

12 000 g is the same as 12 kg,

and so on. As you can see, since there are 1 000 g in each kg, one way to change grams to kilograms is to divide by 1 000. For example

$$1\ 000\ g = \frac{1\ 000}{1\ 000}\ kg = 1\ kg.$$

Or

$$2\ 000\ g = \frac{2\ 000}{1\ 000}\ kg = 2\ kg.$$

As a final example

$$24\ 000\ g = \frac{24\ 000}{1\ 000}\ kg = 24\ kg.$$

Now you try some. Complete this chart. When you have finished, check your answers with the ones on page 61.

| grams g | kilograms kg |
|---|---|
| 3 000 | 3 |
| 6 000 | |
| 9 000 | |
| 15 000 | |

| grams g | kilograms kg |
|---|---|
| 124 000 | |
| | 14 |
| | 84 |
| 97 000 | |

What if something has a mass of 500 g? How many kilograms is this?

This is worked the same way as the other problems.

$$500\ g = \frac{500}{1\ 000}\ kg$$

$$= \frac{5}{10}\ kg$$

$$= 0.5\ kg.$$

So, 500 grams is the same as 0.5 kilogram, or 500 grams is the same as one-half of a kilogram.

What about 350 grams? Change this to kilograms.

$$350\ g = \frac{350}{1\ 000}\ kg$$

$$= \frac{35}{100}\ kg$$

$$= 0.35\ kg.$$

Change 45 grams to kilograms.

$$45 \text{ g} = \frac{45}{1\,000} \text{ kg}$$

$$= 0.045 \text{ kg}$$

As a final example, change 3 500 grams to kilograms.

$$3\,500 \text{ g} = \frac{3\,500}{1\,000} \text{ kg} = 3.5 \text{ kg}.$$

Now you try some. Complete this chart. When you have finished, check your answers with the ones on page 61.

| grams g | kilograms kg |
|---|---|
| 400 | |
| 700 | |
| | 0.6 |
| 250 | |
| 850 | |
| | 0.56 |
| 375 | |
| 472 | |
| | 0.937 |

| grams g | kilograms kg |
|---|---|
| 2 200 | |
| 5 300 | |
| | 4.7 |
| 32 900 | |
| 5 670 | |
| | 9.83 |
| 3 847 | |

## KILOGRAMS TO GRAMS

By now you should be able to change grams to kilograms. What do you do if you need to change kilograms to grams? Let's look at a few examples. Remember that 1 kilogram is the same as 1 000 grams. So,

2 kilograms = 2 × 1 000 g,

or 2 000 grams.

How many grams are there in 7 kilograms?

$$7 \text{ kg} = 7 \times 1\,000 \text{ g}$$

$$= 7\,000 \text{ g}.$$

So, 7 kilograms is the same as 7 000 grams.

$$12 \text{ kg} = 12 \times 1\,000 \text{ g}$$

$$= 12\,000 \text{ grams}.$$

Change 0.45 kilogram to grams.

$$0.45 \text{ kg} = 0.45 \times 1\,000 \text{ g}$$

$$= 450 \text{ grams}.$$

Now you try a few. Complete this chart. When you have finished, check your answers with the ones that are given on page 61.

| kilograms kg | grams g |
|---|---|
| 6 | 6 000 |
| 9 | |
| 87 | |
| | 34 000 |
| 0.8 | |
| 0.32 | |
| 0.04 | 40 |
| | 97 |
| 0.456 | |
| 25.705 | |

## MILLIGRAMS

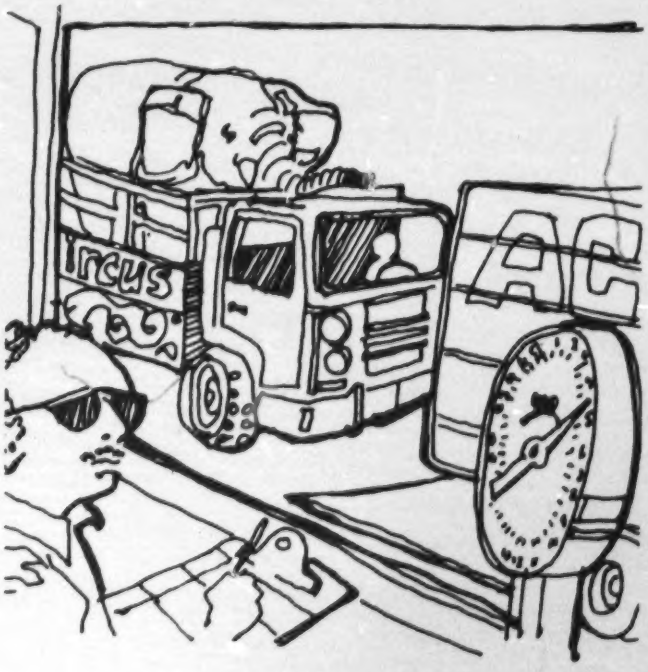
There is one unit smaller than a gram that is used a lot. This unit, the milligram, is one-thousandth of a gram. Thus, there are 1 000 milligrams in one gram. The symbol mg is used for milligram. From your work with grams, you can imagine how light a milligram must be if there are 1 000 of them in a gram.

Milligrams are used in measuring foods and medicines. The amount of each vitamin that is added to food is often given in milligrams. There are about 324 mg in each aspirin tablet.

## METRIC TONS

When someone has to find the mass of something that is very heavy, that person uses a metric ton. A metric ton is 1 000 kilograms. The symbol t is used for metric ton.

What kind of things have masses in metric tons? Large shipments of things like corn and wheat are in metric tons. Other things with masses in metric tons are trucks, large animals such as elephants, and airplanes. An elephant can have a mass of up to 6 metric tons.



The load that a bridge can hold is given in metric tons. Here is a picture of a truck crossing a bridge. The bridge can hold a maximum load of 6 metric tons. Will the bridge hold this truck? The truck driver must know the mass of the truck and its contents before the truck is driven across the bridge.

## LITRES AND KILOGRAMS

There is a very interesting connection between a litre and a kilogram. The following activities will help you see this relationship.

### Metric Activities

#### Activity 45. WATER LITRE

Go to the resource table and get a litre container and a kilogram scale. Put the litre container on the kilogram scale and adjust the scale so that the reading is at zero. Now add water to the container (a few drops of food coloring may make the water easier to see) until there is exactly one litre of water. What is the mass of this litre of water? Is it one kilogram? It should be!

#### Activity 46. BUCKETS OF KILOGRAMS

In Activity 32 (FILL THE BUCKET), you filled a bucket with water. As you filled the bucket, you marked the height of each litre on the inside of the bucket. In Activity 45 (WATER LITRE), you found that one litre of water has a mass of one kilogram. If you fill your bucket with water, what do you think the mass of that water will be? Use a kilogram scale, fill the bucket with water, and check your answer. Did you remember to set the scale at zero when you put the empty bucket on it? Can you think of a way you could find the mass of the water without having to set the scale at zero? (Answer on page 61.)

#### Activity 47. LITRES AND NOT KILOGRAMS

Use the litre container and kilogram scale that you used in Activity 45. Find the mass of a litre of each of the following: rice, beans, sand, flour, sugar, and rocks, or pebbles. Do they each have a mass of one kilogram? Do any have a mass of more than one kilogram? Do any have a mass of less than one kilogram?

# TEMPERATURE

## DEGREES CELSIUS

Thermometers are used to measure temperature. For example, we often want to know the temperature of persons, of rooms, of ovens, of the outdoors.

The metric thermometer is called a Celsius thermometer. It was named after the man who created it, Anders Celsius.

Temperatures are given in degrees Celsius (°C). Water boils at about 100°C (100 degrees Celsius). It freezes at about 0°C (zero degrees Celsius). A normal body temperature is about 37°C.

## Metric Activities

### Activity 52. READING DEGREES

Your teacher will use the Celsius demonstration thermometer and show you how to read it.

### Activity 53. TAKING TEMPERATURES

You will find some thermometers and some cans of water on the resource table. Some water will be very hot and some will be very cold. Use the thermometer and find out how hot or cold each can of water is. Write down your answer. Did everyone in the class get the same answer? Why? How cold was the ice water? How hot was the boiling water?

### Activity 54. AROUND AND ABOUT

Take the temperature of the room at several places:

Near the window.
In the middle of the room.
Near the floor.
Near the door.
Near the ceiling.

Are the readings all the same? Is the temperature near the ceiling higher or lower than the temperature near the floor? If they are different, can you tell why?

### Activity 55. IN AND OUT

Take some temperatures outside:

| | |
|---|---|
| In the sun. | Under a tree. |
| In a car. | Next to the building. |
| In the shade. | Next to a window. |

Make sure you stay in each place long enough for the thermometer to change. What is the highest temperature and where was it taken? What is the lowest? How many degrees difference is there between the highest and the lowest temperatures?

### Activity 56. FEVER

The teacher will show you how to read a clinical Celsius demonstration thermometer. When does someone have a fever? What is a high temperature?

### Activity 57. BODY TEMP

Use one of the clinical thermometers and take your temperature. Is your temperature 37°C?

Activity 48. APPLE MASS

In Activity 26 (APPLE VOLUME), you found the volume of an apple. Put 500 ml of water in a litre measuring container. Gently lower the apple into the water. How high is the water level? How much does the water level rise?

Take the apple out of the water; dry it off; find its mass by putting it on a gram scale. Compare the mass of the apple and the number of millilitres the water level rises. They should be the same.

Divide the mass of the apple by the volume of the apple. Carry the division to two decimal places This number is called the density of the apple. Is your answer less than one? (Compare your answer with some of the other students' answers.) Check your answer with the one on page 61.

Activity 49. WOOD MASS

Repeat Activity 48 (APPLE MASS), only use a block of wood instead of an apple. The mass of the wood in grams should be the same as the rise in the water level in millilitres.

The mass of any object that floats is the same as the mass of the increase in the water level.

Find the volume of the block of wood in cubic centimetres. Divide the mass of the wood in grams by the volume of the wood to get the density of the wood. Is your answer less than one? Is your answer the same as the rest of the students' answers? Check your answer with the one on page 61.

Activity 50. ROCKY MASS

In Activity 25 (ROCKY VOLUME), you found the volume of a rock. What is the mass of the rock? Put the rock on the scale and find it's mass.

Divide the mass of the rock in grams by the volume of the rock in cubic centimetres. This is the density of the rock. Is the density of the rock less than one? Is it more than one? Check your answer with other students' answers.

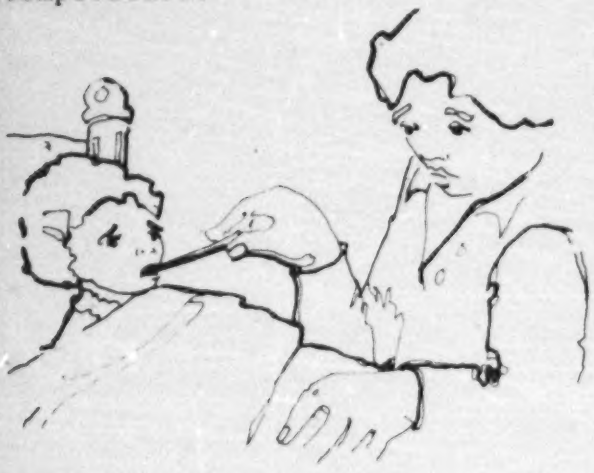
Does the apple float? Does the block of wood float? Does the rock float? When you divide the mass by the volume and the object floats, the density is _____ (less than, equal to, or more than) one. When the object sinks, the density is _____ (less than, equal to, or more than) one. (See page 61 for the correct answers.)

Activity 51. SPECIFIC BRICK

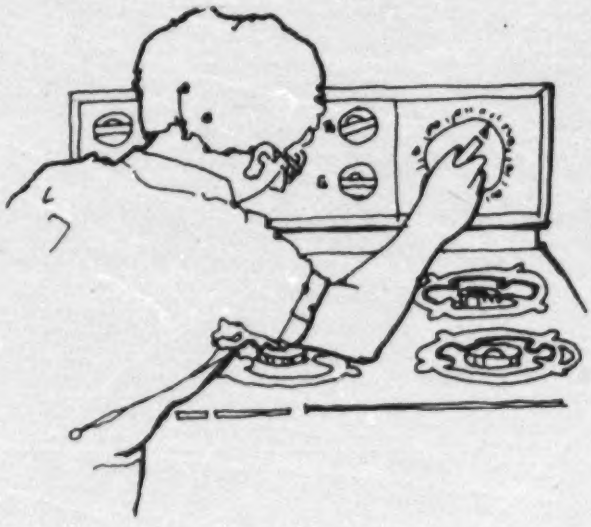
In Activity 40 (WHAT'S ITS MASS), you found the mass of a brick. Find its volume and compute its density. Is the density more than one? Will the brick float?

## Metrics at Work and at Home

When someone is sick, you can take that person's temperature with a thermometer. The temperature reading will tell if you need to call the doctor. The man in the picture is taking his child's temperature.



A person who is not sick will have a temperature of about 37°C. If their temperature is 39°C or higher, they are pretty sick and should see a doctor.



You also use degrees Celsius in cooking and baking. When you use the oven, you need to set the correct temperature. Cakes and cookies are baked at around 170°C. Bread is baked at 200°C. A very slow oven would be 120°C. A hot oven is 210°C, and a very hot oven is about 240°C. When cooking candy the thermometer should read around 120°C.

The man in the picture just got his heating bill. As you can see, it is cold outside and he seems to be very hot. He is not very happy about his heating bill and would like to make it lower. What can he do?

One look at the Celsius thermometer tells him just how hot it is. What can he do to make it cooler? He can reduce the temperature of the air in his house to about 21°C. This would be a very comfortable temperature and should save him some money.

People who install heating and cooling systems in homes and businesses use thermometers. People in nursing and medicine use thermometers; people who work in animal clinics also use thermometers. People who work in plant nurseries use thermometers. Can you think of other kinds of jobs where using thermometers is important?

* * * *

You have now finished this workbook. As you have gone through this book you have read about the metric system, you have used the metric system, and you have read about people using the metric system at home and at work. You are now ready to use the metric system at home, at work, and at play.

## Page 6

There are 10 decimetres in one metre.

## Page 7

There are 10 centimetres in one decimetre.
There are 100 centimetres in one metre.

## Page 14

| centimetres cm | millimetres mm |
|---|---|
| 2.6 | 26 |
| 4.5 | 45 |
| 24 | 240 |
| 16 | 160 |
| 36.7 | 367 |
| 7.8 | 78 |
| 19.2 | 192 |
| 0.4 | 4 |

## Page 16

| steps | metres | kilometres |
|---|---|---|
| 6 000 | 6 000 | 6 |
| 12 000 | 12 000 | 12 |
| 8 500 | 8 500 | 8.5 |
| 4 500 | 4 500 | 4.5 |
| 32 400 | 32 400 | 32.4 |
| 6 780 | 6 780 | 6.78 |
| 5 800 | 5 800 | 5.8 |
| 4 920 | 4 920 | 4.92 |
| 400 | 400 | 0.4 |
| 6 937 | 6 937 | 6.937 |
| 8 394 | 8 394 | 8.394 |
| 38 693 | 38 693 | 38.693 |

## Page 17

A to C = 3.3 km
B to D = 6.7 km
C to D = 11.9 km
B to C = 12.8 km

## Page 18

E to G = 48.3 km
F to G = 46.2 km
G to H = 27 km
H to F = 54 km

## Page 19

New York and Los Angeles = 4 350 km
Boise and St. Louis = 2 490 km
New York and Boston = 300 km
Chicago and Atlanta = 1 080 km
Dallas and Boston = 2 760 km
Los Angeles and Seattle = 1 740 km
Denver and Chicago = 1 650 km

## Page 22

| kilometres km | metres m | centimetres cm | millimetres mm |
|---|---|---|---|
| 1 | 1 000 | 100 000 | 1 000 000 |
| 2 | 2 000 | 200 000 | 2 000 000 |
| 3 | 3 000 | 300 000 | 3 000 000 |
| 4 | 4 000 | 400 000 | 4 000 000 |
| 5 | 5 000 | 500 000 | 5 000 000 |
| 12 | 12 000 | 1 200 000 | 12 000 000 |
| 0.5 | 500 | 50 000 | 500 000 |
| 1.5 | 1 500 | 150 000 | 1 500 000 |
| 8.3 | 8 300 | 830 000 | 8 300 000 |
| 0.05 | 50 | 5 000 | 50 000 |
| 0.08 | 80 | 8 000 | 80 000 |
| 0.009 | 9 | 900 | 9 000 |
| | 6.5 | 650 | 6 500 |
| | 4 | 400 | 4 000 |
| | 0.8 | 80 | 800 |
| | 0.025 | 2.5 | 25 |
| | 0.148 | 14.8 | 148 |
| | 6.39 | 639 | 6 390 |
| | 0.003 | 0.3 | 3 |
| | 0.094 | 9.4 | 94 |
| | 5.786 | 578.6 | 5 786 |
| | 8.940 | 894 | 8 940 |
| | 0.137 | 13.7 | 137 |
| | 4.786 | 478.6 | 4 786 |

## Page 23

a) 3.407 m = 340.7 cm
b) 485 cm = 4.85 m
c) 3.021 m = 3 021 mm
d) 70 cm = 0.7 m
e) 25 km = 25 000 m
f) 1 784 m = 1.784 km
g) 3.582 km = 3 582 m
h) 45 cm = 450 mm
i) 650 cm = 6.5 m
j) 5.4 km = 5 400 m
k) 4 832 mm = 4.832 m
l) 8 639 mm = 863.9 cm
m) 385 m = 0.385 km
n) 74.3 cm = 743 mm
o) 0.75 m = 75 cm

## Page 25

| Length | Width | Area | |
|---|---|---|---|
| 4 m | 6 m | 24 $m^2$ | |
| 8 cm | 2 cm | 16 $cm^2$ | |
| 25 cm | 17 cm | 425 $cm^2$ | |
| 5.2 m | 9 m | 46.8 $m^2$ | |
| 4.3 cm | 20 cm | 86 $cm^2$ | |
| 18 m | 150 cm | 27 $m^2$ | or 270 000 $cm^2$ |
| 270 cm | 1.6 m | 4.32 $m^2$ | or 43 000 $cm^2$ |

## Page 34

It will take 6 $m^3$ for this driveway.
The cost of the concrete is $231.00.

## Page 43

| millilitres ml | litres l |
|---|---|
| 3 000 | 3 |
| 6 000 | 6 |
| 8 000 | 8 |
| 14 000 | 14 |
| 87 000 | 87 |
| 114 000 | 114 |
| 16 000 | 16 |
| 63 000 | 63 |
| 274 000 | 274 |
| 94 000 | 94 |

## Page 44

| millilitres ml | litres l |
|---|---|
| 300 | 0.3 |
| 700 | 0.7 |
| 200 | 0.2 |
| 900 | 0.9 |
| 250 | 0.25 |
| 870 | 0.87 |
| 470 | 0.47 |
| 275 | 0.275 |
| 188 | 0 188 |
| 869 | 0.869 |
| 396 | 0.396 |
| 3 300 | 3.3 |
| 7 400 | 7.4 |
| 5 200 | 5.2 |
| 23 800 | 23.8 |
| 8 760 | 8.76 |
| 9 430 | 9.43 |
| 5 839 | 5.839 |

## Page 45

| litres l | millilitres ml |
|---|---|
| 8 | 8 000 |
| 5 | 5 000 |
| 46 | 46 000 |
| 32 | 32 000 |
| 0.4 | 400 |
| 0.53 | 530 |
| 0.07 | 70 |
| 0.096 | 96 |
| 0.583 | 583 |
| 47.639 | 47 639 |

Page 46

The engine displacement in millilitres of a 6.6 litre car is 6 600 ml.

Page 46

| litres<br>l | millilitres<br>ml |
|---|---|
| 1.75 | 1 750 |
| 1 | 1 000 |
| 0.75 | 750 |
| 0.5 | 500 |

Page 51

| grams<br>g | kilograms<br>kg |
|---|---|
| 3 000 | 3 |
| 6 000 | 6 |
| 9 000 | 9 |
| 15 000 | 15 |

| grams<br>g | kilograms<br>kg |
|---|---|
| 124 000 | 124 |
| 14 000 | 14 |
| 84 000 | 84 |
| 97 000 | 97 |

Page 52

| grams<br>g | kilograms<br>kg |
|---|---|
| 400 | 0.4 |
| 700 | 0.7 |
| 600 | 0.6 |
| 250 | 0.25 |
| 850 | 0.85 |
| 560 | 0.56 |
| 375 | 0.375 |
| 472 | 0.472 |
| 937 | 0.937 |

| grams<br>g | kilograms<br>kg |
|---|---|
| 2 200 | 2.2 |
| 5 300 | 5.3 |
| 4 700 | 4.7 |
| 32 900 | 32.9 |
| 5 670 | 5.67 |
| 9 830 | 9.83 |
| 3 847 | 3.847 |

Page 53

| kilograms<br>kg | grams<br>g |
|---|---|
| 6 | 6 000 |
| 9 | 9 000 |
| 87 | 87 000 |
| 34 | 34 000 |
| 0.8 | 800 |
| 0.32 | 320 |
| 0.04 | 40 |
| 0.097 | 97 |
| 0.456 | 456 |
| 25.705 | 25 705 |

Page 54

Find the mass of the empty bucket and the mass of the full bucket and subtract.

Page 55 Activity 48.

Your answer should be less than one.

Page 55 Activity 49.

Your answer should be less than one.

Page 55 Activity 50.

less than

more than

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